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FIRST REPORT OF *EUONYMUS FORTUNEI* (CELASTRACEAE) NATURALIZED IN TEXAS

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ABSTRACT

Euonymus fortunei is documented here for the first time to occur outside of cultivation in Texas. The population, which is perhaps a large clone spread from an original planting, is in Overton Park in the central part of Fort Worth. Flowers and fruits have not been observed. Color photos are included.

KEY WORDS: *Euonymus fortunei*, Celastraceae, naturalized, Texas

Euonymus fortunei (Turcz.) Hand.-Mazz. Winter creeper, climbing euonymus

Texas. Tarrant Co.: Fort Worth, Overton Park near intersection of Owenwood Drive and Glenwood Drive, terrace bank on south side of Overton Creek, along 60 feet of embankment and covering ca. 600-800 square feet, apparently spread downslope from an original plantings near a house ca. 50 feet above, in a thicket of *Prunus carolinianа*, *Photinia serratifolia*, *Ligustrum lucidum*, *Ligustrum quihoui*, *Nandina domestica*, under *Ulmus crassifolia* and young *Bumelia lanuginosa* and *Celtis laevigata*, with *Hedera helix*, the euonymus also spreading out of the thicket into adjacent mowed areas, 18 May 2009, *G.L. Nesom 2010-01* (BRIT, OKL, TEX, to be deposited).

Euonymus fortunei is an evergreen, trailing or scandent subshrub native to southeastern Asia. At the Overton Park site, it densely covers the ground, intermixed in one area with *Hedera helix*, and has grown nearly 10 feet out of the thicket into grassy areas into a constantly mowed area. Internodal adventitious roots enable the spread, and it is likely that this entire 600-800 square feet of euonymus growth is a single large clone. On the main trunk of an elm in the canopy above the thicket, the euonymus has grown upward to about 8 feet — clusters of adventitious aerial roots keep stems tightly attached to the bark. One cluster of aerial stems, presumably the potentially reproductive branches, diverges outward from the trunk and lacks aerial roots.

Winter creeper is very commonly cultivated as a ground cover in the Dallas-Fort Worth area and appears to flourish, through extreme heat and extreme cold, but it rarely has an opportunity to grow outside of manicured areas. Various sources note that it flowers only or usually when climbing and almost never when trailing along the ground. I have not seen it in flower in Texas, but photos on the Serviss (2009) web site show it in flower and heavy fruit in Arkansas and the distribution in 11 scattered counties in Tennessee (Chester et al. 2010; TEPPC 2009, listed as a "severe threat") suggests that it is successfully dispersing there beyond what could be expected simply through clonal spread. Serviss notes that "the species is "naturalized in Arkansas, seemingly more so in the northern portions of the state." Weakley (2009) notes that it is "rarely naturalized, as in bottomlands or swamps, where sometimes climbing into the canopy," and provides a key to nine species of *Euonymus*, six of which are non-native. Bottomlands and riparian habits also are characteristic of naturalized *E. fortunei* in eastern Kansas (Freeman & McGregor 1998). Spontaneous plants are noted

to climb on walls and fences, into trees, and onto utility poles in cities of eastern Nebraska (Kaul et al. 2006).

Euonymus fortunei (including *E. kiautschovicus* Loes., see synonyms below) is reported by the PLANTS Database (2009) from Ontario, Canada, 22 states in the eastern USA east of the Mississippi River, and 3 states west of the Mississippi (Arkansas, Kansas, and Missouri). The records are documented by various published and unpublished databases, checklists, floras, and personal communications. Notice by Kaul et al. (2006) of its occurrence in Nebraska apparently has not yet been picked up by national databases. It has not been recorded as naturalized in Louisiana or Oklahoma, but it seems likely that it could be found there, at least in situations similar to the one reported here for Texas.

Other commentaries and information on *Euonymus fortunei* in the USA are given in various invasive species web sites (e.g., Miller 2003; Center for Invasive Species and Ecosystem Health 2010). Detailed information on the species and a comprehensive set of references, covering the geographic extent, biology, invasiveness, and control measures, are provided by Zouhar (2009).

All USA records for *Euonymus fortunei* in the PLANTS Database except two are identified as var. *radicans* (Sieb. ex Miq.) Rehder; var. *fortunei* is reported from Illinois, based on Mohlenbrock (1986), and from Massachusetts, based on an unpublished 1992 checklist by Bruce Sorrie. In the recent overview of *Euonymus* in China, Ma et al. (2008) treated *E. fortunei* without formal infraspecific variants, noting that "Numerous taxa have been named within the *E. fortunei* complex but many of these refer to cultivated plants and are best treated as cultivars." They also observed that it is "the most common and widespread species in the genus … and is also the most complex and polymorphic." Dirr (1998) noted that it is "a variable species because it sports (mutates) so readily and the range of leaf types produced is almost endless."

Dirr (1998) provided brief characterizations of 51 cultivars of the species, including "Coloratus" (purple-leaved winter creeper), sometimes referred to as "var. *coloratus*." This name, however, apparently does not exist at varietal rank, but *Euonymus fortunei* forma *coloratus* (Rehder) Rehder is validly published (see below). The form "differs only in the leaves assuming in autumn a purple color retained during the winter, a very dark deep purple on the upper and a brighter and lighter purple on the lower surface" (Rehder 1938, p. 77).

In the Flora of Nebraska (Kaul et al. 2006), the species was identified as *Euonymus hederaceus* Champ. ex Benth. (1851), a name now considered a synonym of *E. fortunei* but published earlier than *Elaeodendron fortunei* Turcz. (1863), the basionym for *E. fortunei*. Use of *E. hederaceus* was correct in 2006, but the next year, 2007, formal conservation of the widely used *E. fortunei* was recommended by the Committee for Vascular Plants (Brummitt, Taxon 56: 1291. 2007), following a proposal for conservation by Cao and Ma (Taxon 55: 233. 2006).

Synonymy of names commonly associated with *Euonymus fortunei*, as noted by Rehder (1940), Bailey (1945), Blakelock (1951), Bean (1973), and Ma et al. (2008), is given below. Many other synonyms are not included.

Euonymus fortunei (Turcz.) Hand.-Mazz., Symb. Sin. 7(3): 660. 1933. *Elaeodendron fortunei* Turcz., Bull. Soc. Imp. Naturalistes de Moscou 26: 603. 1863. Conserved name. Type from China.

Euonymus hederaceus Champion ex Benth. in Hook., Kew J. 3: 333. 1851. Name rejected against *E. fortunei* (Turcz.) Hand.-Mazz. Type from China.

Euonymus japonicus var. *radicans* Sieb. ex Miquel, Ann. Mus. Bot. Lugduno-Batavum 2: 86. 1865. *Euonymus radicans* (Sieb. ex Miquel) Sieb. ex Hand.-Mazz., Symb. Sin. 7(3): 660. 1933 [non (Miquel) Sieb. ex Miquel, Ann. Mus. Bot. Lugduno-Batavum 3: 202. 1876, in obs.]. *Euonymus fortunei* var. *radicans* (Sieb. ex Miquel) Rehder, J. Arnold Arb. 19: 77. 1938. *Euonymus fortunei* forma *radicans* (Sieb. ex Miquel) Rehder, Man. Cult. Trees (ed. 2), 559. 1940. Type from Japan.

Euonymus carrierei Vauvel, Vulgaris Hort., No. 6. 1881 [Carrière, Rev. Hort., 373, fig. 92. 1881]. *Euonymus radicans* var. *carrierei* (Vauvel) G. Nichols., Hand-list Trees Shrubs Kew 1: 67. 1894. *Euonymus japonicus* var. *carrierei* (Vauvel) G. Nichols. & Mottet, Dict. Hort. Jard. 2: 351. 1894. *Euonymus fortunei* forma *carrierei* (Vauvel) Rehder, J. Arnold Arbor. 19: 79. 1938. Type cultivated, from China?

Euonymus kiautschovicus Loes. in Engl. Jahrb. 30: 453. 1902. Type from China.

Euonymus radicans var. *vegetus* Rehder in Sargent, Trees & Shrubs 1(3): 129, pl. 65. 1903. *Euonymus fortunei* var. *vegetus* (Rehder) Rehder, J. Arnold Arb. 19: 80. 1938. *Euonymus fortunei* forma *vegetus* (Rehder) Rehder, Man. Cult. Trees (ed. 2), 559. 1940. Type from Japan.

Euonymus patens Rehder in Sargent, Trees & Shrubs 1(3): 127, pl. 64. 1903. *Euonymus kiautschovicus* var. *patens* (Rehder) Loes., Pl. Wilson. 1(3): 486. 1913. *Euonymus fortunei* var. *patens* (Rehder) Hand.-Mazz., Symb. Sin. 7(3): 660. 1933. Type from China.

Euonymus japonicus var. *acutus* Rehder, Pl. Wilson. 1(3): 485. 1913. *Euonymus radicans* var. *acutus* Rehder, Mitt. Deutsch. Dendr. Ges. 22: 257. 1913. Type from China.

Euonymus radicans var. *kewensis* Bean, Trees Shrubs Brit. Isl. 1: 542. 1914. *Euonymus fortunei* forma *kewensis* (Bean) Rehder, J. Arnold. Arb. 28: 445. 1947. *Euonymus kewensis* (Bean) H.A. Hesse in Möller's Deutsch. Gärtn.-Zeit. 47: 217. 1932. Type from Japan.

Euonymus radicans var. *coloratus* (Rehder) Rehder, Man. Cult. Trees, 552. 1927. *Euonymus radicans* var. *acutus* forma *coloratus* Rehder, J. Arnold Arb. 7: 30. 1926. *Euonymus fortunei* forma *coloratus* (Rehder) Rehder, J. Arnold Arb. 19: 77. 1938. Type from China.

Euonymus radicans [unranked] *minimus* Simon-Louis, Cat. 1912-1913: 43. 1912. *Euonymus radicans* var. *minimus* (Simon-Louis) Rehder in Bailey, Stand. Cycl. Hort. 2: 1188. 1914. *Euonymus fortunei* forma *minimus* (Simon-Louis) Rehder, J. Arnold Arbor. 19: 79. 1938. Type from China.

Euonymus fortunei var. **villosus** (Nakai) H. Hara, Enum. Sperm. Jap. 3: 86. 1954. *Euonymus radicans* Sieb. ex Miquel var. *villosus* Nakai in J. Jap. Bot. 17: 679. 1941. Type from Japan.

Var. *villosus* is endemic to Japan (western Honshu and Kyushu) and recognized as a valid entity by Noshiro (1999) and in the Flora of Japan Database (2010). Typical *E. fortunei* also occurs in Japan.

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PHOTOS ONLINE

1. Close-up of the creeping form of the plant, arising here from numerous interlacing stems.
2. Buds 3–5 mm long from creeping stems (left); buds 10–11 mm long from aerial stems (right).
3. Aerial roots (left) and internodal adventitious roots (right) of creeping stems.
4. Aerial stems growing up trunk of an elm tree.

5 and 6. Edge of the population.

7. Locality in Overton Park, showing the extent of the whole euonymus population, which completely covers the inside of the thicket and extends out along the grassy margins.

Margination modified 2 Mar 2010, no other changes

Nesom, G.L. 2010. *Pyracantha* (Rosaceae) naturalized in Texas and the southeastern United States.
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PYRACANTHA (ROSACEAE) NATURALIZED IN TEXAS AND THE SOUTHEASTERN UNITED STATES

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ABSTRACT

Pyracantha coccinea, *P. fortuneana*, and *P. koidzumii* are recognized to occur outside of cultivation in Texas, and herbarium collections are cited in documentation of their occurrence in Texas and in other states of the southeastern USA. A key includes these and two other species: *P. angustifolia*, a very distinctive species that is cultivated in the southeastern USA, and *P. atalantioides*, a species that has sometimes been mistakenly identified in the same region. The taxonomic distinction between *P. fortuneana* and *P. cremulata* is problematic.
KEY WORDS: *Pyracantha*, naturalized, Texas, southeastern USA

With stimulation by the recent report and clarification by Serviss (2009) for Arkansas and by the need to accurately portray the naturalized non-native flora of Texas (Nesom 2009a, 2009b), an overview of introduced *Pyracantha* M. Roemer in the state is presented here. To broaden the context, taxa are included from other states in the southeastern USA, as represented by collections in BRIT-SMU-VDB, GH, MO, and TEX-LL.

Pyracantha was not included in the floristic account for Texas by Correll and Johnston (1970). Johnston's floristic update (1990) included the genus with the line "732. Add: *Pyracantha coccinea* M.J. Roemer" — without other documentation. Turner et al. (2003) mapped one species of *Pyracantha* for Texas (15 counties), identifying it as *P. coccinea*. For the southeastern USA, Robertson (1974) noted only *P. coccinea* and *P. koidzumii* (Hayata) Rehder as naturalized, the latter only from South Carolina, as reported by Clark et al. (1973). The PLANTS Database (USDA, NRCS 2009) indicates that these two as well as *P. fortuneana* are becoming more widely naturalized in the Southeast.

The key below allows distinction of the three species naturalized in Texas and the southeastern USA (*P. coccinea*, *P. fortuneana*, and *P. koidzumii*) and also includes two other species: *P. angustifolia*, a distinctive species cultivated in the southeastern USA, and *P. atalantioides*, a species sometimes mistakenly identified in the same region. As with other commonly cultivated species, placing a plant in one or another species may be an artificial classification, because hybrids of *Pyracantha* are sold and planted and cultivars often apparently cannot be unequivocally assigned to a single species in its typical expression. Several cultivars are explicitly indicated by Meyer et al. (1994) to be of hybrid origin (*P. koidzumii* x *P. fortuneana*; *P. koidzumii* x *P. coccinea*).

There appparently are only about 10 or fewer species of *Pyracantha* in the world, and no critical overview of the genus has been published. Nine species occur in China (Gu & Spongberg 2003). Compilations by Meyer et al. (1994) and Egolf and Andrick (1995) indicate that hundreds of cultivars exist.

1. Leaf blades 4–8 mm wide, abaxially densely and persistently tawny-puberulent to puberulent-villous, margins entire ..... **Pyracantha angustifolia**
1. Leaf blades 5–25 mm wide, abaxially glabrous or quickly glabrescent, margins entire or crenate to crenulate-serrate or apiculate.

2. Leaf margins entire or occasionally 1–3(5) very shallow teeth per side, apices rounded to truncate, usually retuse ..... **Pyracantha koidzumii**
2. Leaf margins usually crenate to crenulate or crenulate-serrate with numerous teeth or apiculae, apices mostly acute or obtuse to rounded or truncate, rarely retuse.

3. Leaf blades narrowly elliptic to rhombic-elliptic, sometimes narrowly so, apices acute, margins crenate to crenulate ..... **Pyracantha coccinea**
3. Leaf blades narrowly obovate to obovate-oblanceolate (widest above the middle) or oblong to elliptic (widest at the middle), apices obtuse to rounded, truncate, or retuse, margins very shallowly to minutely serrulate, crenulate-serrate, or apiculate, less commonly apparently entire in *P. atalantioides*.

4. Leaf blades narrowly obovate to obovate-oblanceolate (widest above the middle) ..... **Pyracantha fortuneana**
4. Leaf blades oblong to elliptic (widest at the middle) ..... **Pyracantha atalantioides**

PYRACANTHA COCCINEA M. Roemer, Fam. Nat. Syn. Monogr. 3: 219. 1847.

Leaf blades narrowly elliptic to rhombic-elliptic, sometimes narrowly so, 16–40 mm x 6–14 mm, glabrous adaxially, glabrous or quickly glabrescent abaxially, apices acute, margins crenate to crenulate

ALABAMA. **Hale Co.**: 4.2 mi W of Faunsdale, shrub in chalk glade, 9 Sep 1968, *Kral 33085* (VDB). **LOUISIANA**. **St. Landry Par.**: Opelousas, spontaneous in some places, Aug 1883, *Letterman s.n.* (GH). **OKLAHOMA**. **Payne Co.**: ca. 0.5 mi NW of Stillwater, 10 Oct 1947, *Harn 93* (SMU). SOUTH CAROLINA. **Anderson Co.**: Murray[?], 1 Oct 1919, *Davis s.n.* (MO). **TENNESSEE**. **Davidson Co.**: vicinity of Nashville, no date, *Gattinger s.n.* (GH); vicinity of an old Federal fort near Nashville, low swampy meadow near New Lake, Jul 1884, *Gattinger s.n.* (GH). **Knox Co.**: 4.2 air mi ESE of downtown Knoxville, south-central section of Eastern State Wildlife Management Area, along trail, edge of cedar barren, 18 Mar 2006, *Estes 8689* (VDB). **TEXAS**. **Angelina Co.**: 10 mi SE of Zavalla, 4 Apr 1980, *Fritz s.n.* (BRIT). **Scurry Co.**: Dunn, sandy loam, 23 Oct 1965, *Fuller 20* (SMU).

Most records identified by the Invaders of Texas database (2009) as *P. coccinea* are *P. koidzumii* and *P. fortuneana*. Records 7673 and 7744 from Bexar Co. are *Forestiera pubescens* Nutt.; record 7672 from Bexar Co. is *Condalia hookeri* M.C. Johnston. At least 23 cultivars in the southeastern USA are derived from *P. koidzumii* (Meyer et al. 1994).

Also naturalized in British Columbia; California, District of Columbia, Georgia, Mississippi, North Carolina, New Mexico, New York, Ohio, Oregon, Pennsylvania, South Carolina, Utah, and Virginia (fide PLANTS Database). Naturalized in Missouri: Madison Co.: St. Francis River, Silver Mine Rec. Area, USFS/MDC, glade next to river, 6 Aug 1996, *Erickson 96A* (MO). A report of *P. coccinea* from Arkansas appears to represent a plant persisting from cultivation (Serviss 2009). The PLANTS Database record for Florida stems from Robertson (1974), but a voucher is not known and *P. coccinea* is regarded an "excluded species" for that state (Bruce Hansen pers. comm., 2009). Native to from southern Europe to western Asia; naturalized in Europe, South Africa, Australia, Japan.

PYRACANTHA FORTUNEANA (Maxim.) H.L. Li, J. Arnold Arbor. 25: 420. 1944.

Photinia fortuneana Maxim., Bull. Acad. Imp. Sci. St-Petersbourg 19: 179. 1873

Pyracantha crenatoserrata (Hance) Rehder, J. Arnold Arbor. 12: 72. 1931.

Leaf blades narrowly obovate to obovate-oblanceolate (widest above the middle), 15–60 mm x 5–20(–25) mm, glabrous to glabrescent on both surfaces, apices usually obtuse to rounded or truncate, margins very shallowly to minutely serrulate, crenulate-serrate, apiculate with 6–15 teeth, smaller leaves on a branch or plant with fewer teeth, very rarely a few leaves subentire.

ALABAMA. Randolph Co.: NW of Wadley on Ala. Hwy 77, shrub at edge of granite glade, Almond Outcrop, 24 Jul 1990, *Kral 77969* (VDB). **SOUTH CAROLINA. Oconee Co.**: W of the city of Walhalla, Chauga River at SC Rte 290, dense thicket along the river, 22 May 1988, *Spongberg & Boufford 17111* (GH). **TEXAS. Wood Co.**: residential area with oak, pine, elm, etc., 0.9 mi S of jct Hwy 37 and Coke Road, 10 Oct 1971, *White 10* (SMU). The Invaders of Texas database (2009) has records of *P. fortuneana* from Bexar Co. (7625, 7931, 7489, 7084?, 6471?, 6466?, 5596?), Burnet Co. (5796), and Travis Co. (1462, 8162).

Also naturalized in California (fide PLANTS Database). An image of a collection of *P. fortuneana* collection from Florida is available on the Atlas of Florida Vascular Plants (Wunderlin & Hansen 2008): Okaloosa Co. (*Wilhelm 11939*, USF) — this plant, which has regrown from the very base after being mowed along a roadside, has obovate, atypically small leaves coarsely toothed distally and it might be a growth form of *P. koidzumii*, which is more commonly naturalized in Florida. Native to China; naturalized in Australia, New Zealand, Hawaii. At least 7 cultivars in the southeastern USA are derived from *P. koidzumii* (Meyer et al. 1994).

PYRACANTHA KOIDZUMII (Hayata) Rehder, J. Arnold Arbor. 1: 261. 1920.

Cotoneaster koidzumii Hayata, J. Coll. Sci. Imp. Univ. Tokyo 30: 101. 1911.

Leaf blades usually oblong or narrowly elliptic to elliptic-obovate, obovate, or narrowly obovate, 11–38 mm x 5–15 mm, glabrous on both surfaces, apices rounded to truncate, usually retuse, margins entire or occasionally 1–3(–5) very shallow teeth per side.

ALABAMA. Barbour Co.: Ala Rte 165, ca. 0.5 m S of Russell Co. line (ca. 0.7 mi S of Twin Springs), roadbank, 28 Apr 1959, *Wood 9064* (GH). **Crenshaw Co.**: common on fencerow along a field, blackbelt outcrop, County Hwy 11, 4 Jan 2004, *Diamond 14280* (VDB). **Houston Co.**: Dothan, S side of town, overgrown woods, 22 Nov 1992, *McDonald 5746* (VDB); Dothan, S side of town, along fence of cow pasture, 28 Nov 1992, *McDonald 5770* (VDB); ca. 0.5 mi S of Madrid along Atlanta/St. Andrews Bay RR, locally common, 14 Dec 1992, *McDonald 5780* (VDB). **Pike Co.**: Troy, E of ParK Street, fencerow in overgrown area, 7 Nov 2002, *Diamond 13727* (VDB). **Shelby Co.**: roadside of County Rd 17, by dolomite quarry near Ryan, 27 Apr 2002, *Spaulding 11229* (VDB). **FLORIDA. Jackson Co.**: ca. 3 mi W of Cypress on US Rte 90, *Taxodium* swamp and cut-over man-made savannah, roadside, 23 May 1973, *Boufford 9217* (GH); Marianna, edge of woodland, 1 Apr 1973, *Moldenke 26723* (GH, LL). **GEORGIA. Grady Co.**: E side of Cairo, RR embankment, 5 Apr 2003, *Kral 93782* (TEX, VDB). **Montgomery Co.**: 2.4 mi E of Ailey on US 280, 18 May 2004, *Stone et al. 5564* (MO). **Sumter Co.**: ca. 5.5 air mi S of Blains, fencerow, 16 Aug 1997, *Norris 6897* (VDB). **ARKANSAS. Garland Co.**: Hot Springs, ca. one-half block N of Central Avenue, 4500 block, one plant (fruiting), steep bluff with rocky soil, semidisturbed, upland woods habitat, 1 Nov 2008, *Serviss & Serviss 7396* (HEND, fide Serviss 2009). **LOUISIANA. Acadia Par.**: OPEN woods along Bayou Plaquemine ca. 2.5 mi NW of Crowley, 3 Nov 1962, *Thieret 10097* (VDB). **MISSISSIPPI. Oktibbeha Co.**: Hickory Grove, 7 mi E of Starkville, chalk outcrop, 8 May 1988, *McDaniel 29756* (VDB). **OKLAHOMA. Cleveland Co.**: 2.6 mi N on Hwy 77 from Moore Post Office, 4 Oct 1981, *Hoberecht 60* (SMU). **SOUTH CAROLINA.** Spartanburg Co.: 19 Sep 1970, *Clark 19809* (fide Clark et al. 1973). **TEXAS. Bandera Co.**: Hill Country State Natural Area, SE area of the

park, along Trail 2, West Verde Creek floodplain, 13 Nov 1993, *Lackey 343* (BRIT). **Bell Co.**: Killeen city limits, upland edge in park near intersection of Bus. 190 and South WS Young Drive, 250 m, 17 Apr 2004, Stone et al. 4202 (MO). **Blanco Co.**: Blanco State Park, along Nature Trail in SE corner of the park, 0.2 mi E of Park Rd 32, Blanco River floodplain, 27 Apr 1996, *Sanchez 1217* (BRIT). **Comal Co.**: N side of New Braunfels, road shoulder of Loop bypass, above Bleider's Creek, 17 May 1982, *Kral 68559* (VDB). **Coryell Co.**: Fort Hood Military Reservation, Main Cantonment Area, 0.1 mi E of Montague Village, along road that leads to Montague Park (abandoned), along fence line of an abandoned park, 13 Sep 2007, *Hansen 5376* (TEX). **Galveston Co.**: Bacliff [perhaps cultivated], 20 Mar 1974, *Waller 2550* (GH, TEX). **Travis Co.**: Austin, trail from Gaines Creek Nature Area at Southwest Pkwy and Republic of Texas Drive to Barton Creek Greenbelt at MoPac (Loop 1) and Capital of Texas Hwy (Loop 360), 16 Apr 1998, *Siedo 602* (TEX); Austin, Gaines Creek Nature Area and adjacent streambed, corner of Southwest Pkwy and Republic of Texas Drive, ca 1 mi W of Loop 1 (MoPac), mixed oak-juniper woodland with riparian and scrub-grassland assoc., 18 Apr 1999, *Siedo 789* (TEX); Austin, Travis Country Circle ca. 1 mi from jct of of Republic of Texas Drive and Southwest Pkwy (jct ca 1 mi W of Loop 1/MoPac), trail from pool-recreation area, riparian assoc. and adjacent mixed oak-juniper woodland, 23 Apr 1999, *Siedo 836* (TEX). Specimens at TEX from Bell, Brown, Galveston, Hays, and McCulloch counties are from cultivated plants. The Invaders of Texas database (2009) has records of *P. koidzumii* from **Bexar Co.** (7685, 7627, 7493, 7959, 7953, 7343, 5598), **Burnet Co.** (5793), **Kerr Co.** (510, 497, 606, 5931, 5928), **Liberty Co.** (588), **Tarrant Co.** (25300), **Travis Co.** (1462, 1589, 4544), and **Williamson Co.** (5834).

Also naturalized in Arizona and Florida (fide PLANTS Database). Images of *P. koidzumii* collections from Florida are available on the Atlas of Florida Vascular Plants (Wunderlin & Hansen 2008): Citrus Co. (*Lakela 25802*), Hernando Co. (*Correll 52541*), Hillsborough Co. (*King 66*), Okaloosa Co. (*Wilhelm 11495*), Pasco Co. (*Wise 249*), Suwannee Co. (*Whetstone 14335*), and Walton Co. (*Wilhelm 8091*). Naturalized in California: Ventura Co., Oak View, escape from cultivation in brushy strip under Ventura River bluff N of and near Santa Ana Blvd crossing, 23 Oct 1963, *Pollard s.n.* (TEX). Native to Taiwan; naturalized in Australia, Hawaii.

Many of the collections of *Pyracantha koidzumii* from Alabama were originally identified as *P. atalantioides*. The plant from Cleveland Co., Oklahoma, has persistently tomentose adaxial leaf surfaces (glabrous abaxially) and persistently rusty-tomentose branchlets — it perhaps is a hybrid, as typical *P. koidzumii* is glabrous on both leaf surfaces and has quickly glabrescent branchlets. Leaves with entire to subentire margins and retuse apices are characteristic of *P. koidzumii*. At least 11 cultivars in the southeastern USA are derived from *P. koidzumii* (Meyer et al. 1994).

PYRACANTHA ANGUSTIFOLIA (Franch.) C.K. Schneid., Illust. Handb. Laubholzk. 1: 761. 1906.

Cotoneaster angustifolia Franch., Pl. Delavay. 221. 1890.

Leaf blades narrowly oblong, 10–40 mm x 4–8 mm, abaxially densely and persistently tawny-puberulent to puberulent-villous, apex obtuse to rounded, margins entire.

Naturalized in California (fide PLANTS Database). Native to China; naturalized in Australia, Hawaii, New Zealand, South Africa.

PYRACANTHA ATALANTIOIDES (Hance) Stapf, Bot. Mag. 151: t. 9099. 1926.

Sportella atalantioides Hance, J. Bot. 15(175): 207. 1877.

Pyracantha discolor Rehder, J. Arnold Arbor. 1: 260. 1920.

Pyracantha gibbsii A.B. Jackson, Gard. Chron., ser. 3, 60(1566): 309, f. 133.3, 134. 1916.

Leaf blades oblong to elliptic (widest at the middle), 15–50 mm x (5–)7–20(–25) mm, glabrous to glabrescent on both surfaces, apices usually obtuse to rounded or truncate, margins shallowly to minutely crenulate-serrate or apiculate.

Not reported as naturalized in North America (fide PLANTS Database). Native to China.

Pyracantha atalantioides usually is distinguished in keys by entire to serrulate margins (Rehder 1940; Bailey 1945; Gu & Spongberg 2003). The original description by Hance noted that the margins are minutely serrulate and study of many collections from China identified as *P. atalantioides* at GH confirms that serrulate margins are characteristic of the species. In many plants, the teeth are apparent only as minute, black apiculae. Some leaves or entire or nearly so but they usually are on the same branch as distinctly serrulate or apiculate leaves. For accepted synonyms *P. discolor* and *P. gibbsii*, Rehder (1920) described the margins of the former as "usually entire, sometimes inconspicuously serrulate" and those of the latter as "coarsely crenate." Glaucescent abaxial leaf surfaces are a diagnostic feature in the Flora of China key (Gu & Spongberg 2003, apparently following Rehder 1940), but this apparently is variable and most Chinese collections at GH are not at all glaucous or glaucescent. Leaf shape appears to be the most effective way to distinguish *P. atalantioides* from *P. fortuneana* (see key above).

PYRACANTHA CRENULATA (D. Don) M. Roemer, Fam. Nat. Syn. Monogr. 3: 220. 1847.
Mespilus crenulata D. Don, Prodr. Fl. Nepal. 238. 1825.

Naturalized in California (fide PLANTS). Native to China, Bhutan, India, Kashmir, Myanmar, Nepal; naturalized in South Africa, Australia, New Zealand, Japan, Europe.

Pyracantha crenulata is included in this account because as represented by Asian collections at GH, it appears to be indistinguishable from *P. fortuneana*. Collections identified as one or the other species have glabrous, obovate to oblanceolate leaves with margins crenate to crenulate and apices obtuse to rounded or truncate and often apiculate. In the Flora of China (Gu & Spongberg 2003), the two taxa are separated by leaf shape (*P. crenulata*, blades "oblong or oblanceolate, rarely ovate-lanceolate, 2–7 × 0.8–1.8 cm"; vs. *P. fortuneana*, blades "usually obovate to obovate-oblong, 1.5–6 × 0.5–2 cm"). Folders as currently identified at GH do not reflect even this subtle difference, nor was I able to sort the collections in a meaningful way. If indeed there is no difference, the name *P. crenulata* would have priority, and it is a taxon generally recognized as having a wider native distribution. Until a more authoritative assessment is available, continued use here of *P. fortuneana* is arbitrary.

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ADDITIONS TO THE ALIEN VASCULAR FLORA OF MEXICO, WITH COMMENTS ON THE SHARED SPECIES OF TEXAS, MEXICO, AND BELIZE

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ABSTRACT

Comparisons of databases of the alien vascular flora of Texas, Mexico, and Belize indicate that the three regions share 46 alien taxa—18 monocots and 28 dicots. In addition, comparisons revealed 24 alien taxa not previously reported from Mexico. Herbarium records and brief discussions are provided for the newly reported taxa.

KEY WORDS: vascular plants, invasive, non-native, weed, floristics, Texas, Mexico, Belize

Over the course of the last few decades it has been recognized that alien (non-native) plant taxa are contributing to the loss of biodiversity and environmental quality worldwide. The first step in monitoring and controlling the spread of the alien taxa is to identify and map the distribution of the species. Such monitoring efforts have already begun in many political regions (e.g., Kansas, Mexico, and California).

As part of the USDA-funded Sustainable Agricultural Water Conservation (SAWC) program to monitor the biological integrity of the Rio Grande, Sam Houston State University is currently involved in mapping the densities and distributions of the alien flora that occur along the river. To this effect, a database of the alien flora of Texas has been constructed (Williams & Spencer 2005) using data from herbarium specimens, literature, and field surveys. In addition to identifying the distribution of the alien flora in Texas, the project aims to determine metrics by which land managers and policy makers can identify species prone to invasiveness. One of the metrics identified in the study is the overall distribution of an alien species within its non-native range. To determine this, the database of the alien flora of Texas was compared to the alien flora of Mexico and Belize. Methods and results of the study are presented below.

METHODS

A database of the alien flora of Texas was created from herbarium studies, field surveys and various literature sources (Turner et al., 2003; Texas Invasives.org; Correll & Johnston 1970). The database was then compared to the alien flora of Belize (Balick et al. 1999) and Mexico (Villaseñor & Espinosa-Garcia 2004). Several lists were then generated from this comparison: (1) species richness values of the alien taxa in each area (Table 1); (2) taxa that occurred in all three regions (Table 2) and (3) alien taxa that were reported from Texas but not Mexico. The list of taxa reported from Texas and not Mexico was then compared to herbarium specimens from Mexico housed at the University of Texas, Plant Resources Center (TEX-LL). The purpose of the search was to determine if indeed these taxa did occur in Mexico. Numerous alien taxa were identified from Mexico that had not been previously reported. The specimen information was recorded and the verification of the identification was made by the author unless otherwise noted.

RESULTS

Table 1 lists the species richness values of alien taxa from each of the three geographic areas studied. In addition, the table lists the percent of alien taxa in each flora. From the analysis it appears that the flora of Texas includes a much higher percentage of alien taxa than either Belize or Mexico. The reasons for this discrepancy are subject to further analysis. Table 1 also lists the number of taxa that are shared between the three regions. In total there are 46 alien taxa (18 monocots and 28 dicots) that Texas, Mexico, and Belize share. The identification of these taxa is listed in Table 2. Although not listed in table form, the study also identified the number of taxa shared by Texas and Mexico (84 monocots, 176 dicots, 258 total).

The third analysis identified 71 alien taxa from 30 families that were reported from Texas but not from Mexico. The assumption made at the beginning of this study was that some of the taxa identified from Texas might have populations to the south in Mexico. Comparison of this list with herbarium records from Mexico identified 24 alien taxa that were indeed present in Mexico. The list of newly reported alien taxa to Mexico is presented below by family in Table 3. Representative specimens document the records.

DISCUSSION

By increasing our understanding of the distribution of alien taxa we can begin to develop tests and methodologies for prioritizing the taxa of main concern. The list of taxa presented in Table 2 identifies alien species with wide distributions and densities. Taxa that exhibit such a large breadth in distribution should be identified as taxa of concern and future effort should be made to curtail their spread.

Table 1. Species richness values of the alien flora of Texas, Mexico, and Belize. [1]This value calculated from Balick et al. (1999). [2]This value calculated from modified values presented in Villaseñor & Espinosa-Garcia (2004) with the additional 24 taxa presented here included.

	Belize	Mexico	Texas	Shared
Alien monocots	57	200	128	18
Alien dicots	180	441	347	28
Total alien species	237	641	475	46
% flora that is alien	2.8[1]	2.8[2]	9.8	

Table 2. The 46 alien plant species shared by Texas, Mexico, and Belize. A = number of counties in Texas (254 total). B= number of states in Mexico (31 total). C = A + B, this gives a relative idea of the taxon's distribution. The top ten taxa with the widest distributions are in bold.

Family	Species	A	B	C
Malvaceae	*Alcea rosea*	7	12	19
Fabaceae	*Albizia lebbeck*	2	6	8
Basellaceae	*Anredera cordifolia*	4	10	14
Apiaceae	*Apium graveolens var. dulce*	4	14	18
Fabaceae	*Arachis hypogaea*	12	8	20
Poaceae	*Bothriochloa pertusa*	1	8	9
Brassicaceae	*Brassica rapa*	15	26	41
Apocynaceae	*Catharanthus roseus*	4	18	22
Cucurbitaceae	*Citrullus lanatus*	14	13	27
Rutaceae	*Citrus aurantium*	11	11	22
Asteraceae	*Conyza bonariensis*	4	29	33

Apiaceae	*Coriandrum sativum*	14	24	38
Cucurbitaceae	*Cucumis anguria*	2	21	23
Cucurbitaceae	*Cucumis melo*	26	22	48
Poaceae	*Cynodon nlemfuensis*	1	12	13
Cyperaceae	*Cyperus involucratus*	10	19	29
Cyperaceae	*Cyperus rotundus*	62	27	89
Poaceae	*Digitaria ciliaris*	79	28	107
Poaceae	*Echinochloa colona*	76	29	105
Pontederiaceae	*Eichhornia crassipes*	23	29	52
Poaceae	*Eleusine indica*	51	32	83
Asteraceae	*Emilia fosbergii*	2	4	6
Cucurbitaceae	*Lagenaria siceraria*	3	15	18
Scrophulariaceae	*Lindernia crustacea*	1	2	3
Cucurbitaceae	*Luffa aegyptica*	1	17	18
Solanaceae	*Lycopersicon esculentum*	9	25	34
Meliaceae	*Melia azedarach*	74	27	101
Fabaceae	*Melilotus albus*	78	21	99
Poaceae	*Oryza sativa*	13	10	23
Poaceae	*Paspalum urvillei*	75	4	79
Poaceae	*Pennisetum purpureum*	6	16	22
Euphorbiaceae	*Phyllanthus urinaria*	13	4	17
Plantaginaceae	*Plantago major*	22	30	52
Brassicaceae	*Raphanus sativus*	5	14	19
Euphorbiaceae	*Ricinus communis*	13	31	44
Poaceae	*Rottboellia cochinchinesis*	1	4	5
Rutaceae	*Ruta chalapensis*	3	16	19
Solanaceae	*Solanum capsicoides*	3	5	8
Asteraceae	*Sonchus oleraceus*	66	32	98
Poaceae	*Sorghum bicolor*	23	27	50
Poaceae	*Sorghum halepense*	131	30	161
Sphenocleaceae	*Sphenoclea zeylanica*	1	6	7
Poaceae	*Sporobulus indicus*	53	25	78
Poaceae	*Stenotaphrum secundatum*	13	14	27
Poaceae	*Urochloa mutica*	5	16	21
Poaceae	*Vetiveria zizanioides*	2	1	3

Table 3. Alien taxa newly reported for Mexico.

APIACEAE

Cuminum cyminum L. **Chihuahua**: Llano Grande, 19 May 1960, *C.W. Pennington 140* (TEX). Det. Lincoln Constance.

Torilis arvensis (Huds.) Link **Nuevo Leon**: Santiago, Puerto Suizo, 1345 m, oak and pine forest, 16 Jun 1994, *G.B. Hinton 24424* (TEX). Det. Lincoln Constance.

APOCYNACEAE

Nerium oleander L. **Nuevo Leon**: 2 miles N of Monterrey on Hwy 85, in disturbed area, 27 May 1966, *J. Watson 10842* (TEX).

This species is native to the Mediterranean and is widely cultivated throughout Mexico. There are many representative specimens that indicate its cultivated status, but the specimen listed above is the only one collected from a disturbed rather than cultivated area This species has become widely naturalized throughout North America and there is no reason to believe its invasive habit would not persist in Mexico. Because of the heavy concentration of toxic compounds in the leaves, this species is considered an agricultural threat to grazing wildlife. The species is recognized by its shrubby habit, whorled leaves, and pink to red flowers.

ASTERACEAE

Carduus nutans L. **Hidalgo**: 5 mi S of junction MEX 85 with MEX 130, S of Pachuca, 19 Aug 1971, *D. Spellman, J. Dwyer, J. Vaughan, & R. Wunderlin 946* (TEX).

CHENOPODIACEAE

Chenopodium botrys L. **Chihuahua**: 48 km w of La Junta, 20 km E of Tomochic, on La Junta-Baseachic road, 2400 m, floodplain along stream, S of bridge across hwy, 9 Sep 1984, *F. Barrie 986 & M.E. Keidig* (TEX).

This species is readily distinguished from other species of *Chenopodium* by the presence of orange glands along the leaves and dichotomous cymes that are curved. The species is native to Europe and is a naturalized weed along gravelly areas throughout Texas and the Great Plains.

Salsola paulsenii Litv. **Chihuahua**: 82 miles N of Gallego on Hwy 45 S, creosote and *Atriplex* dominant in desert scrub community, 4150 ft, 18 Jul 1975, *E. Wallace 153* (TEX).

This species is native to southeastern Europe and central Asia. It is distinguished from the other alien species of *Salsola* in Mexico, *S. tragus* L., by its longer sepal wings (2.5–4.5 mm vs. 0.5–2.4 mm) and yellowish green leaves (vs. dark green). The species is naturalized in Texas and California.

CONVOLVULACEAE

Ipomoea wrightii A. Gray. **Jalisco**: Mpio. La Huerta, Rancho Cuixmala, on road to beach on NW side of La Loma, low inundated areas along edge of Lagoon, 5 m, 24 Oct 1990, *E. Lott 2869* (TEX). Det. A. MacDonald.

This species is native to India and is readily distinguished from other species of Mexican *Ipomoea* by its palmately compound leaves and twisted peduncles.

EUPHORBIACEAE

Phyllanthus urinaria L. **Chiapas**: Marshes surrounding the Laguna de Catazaja near the Hwy between Villa Hermosa and Merida and E of the town of Bajadas Grandes, 125 m, 11 Oct 1972, *D.E. Breedlove 28744* (TEX). Oaxaca: Orilla del río Santo Domingo, cerca de Sebastopol, 10 Mar 1968, matorrales secundarios, 150 m, *Rzedowski 25494* (TEX). **Veracruz**: Brecha, near Poblado 2, Uspanapa military reseve, secondary growth in cutover tropical rainforest, 17 Jul 1978, *J. Poole 1494* (TEX). All specimens det G. Webster.

This species is native to Sri Lanka and southeast Asia. It may become more widespread in the neo-tropics as more people may import and cultivate the species because of its reputed anti-viral (e.g., Asian flu, herpes simplex, HIV) properties.

FABACEAE

Albizia lebbeck (L.) Benth. **Campeche**: Francisco Escarcega, secondary vegetation, 27 Sep 1983, *E. Cabrera 5584* (TEX). **Sinaloa**: rolling hills 3.8 miles w of Hwy 15 at a point 7 miles N of Mazatlan, along the "Playa" orad, 1.4 m E of where it crosses railroad, thorn forest with *Acacia* and *Ficus*, 100 ft, 27 Dec 1983, *A.C. Sanders et al. 4286* (TEX). **Tamaulipas**: Along rte 85, ca 4-5 miles S of Ciudad Mante, 18 Feb 1961, *R.M. King 3839* (TEX). All specimens det. Barneby & Grimes.

Although there are additional Mexican specimens of *A. lebbeck* at TEX, these are the only specimens that appear naturalized in secondary forest or disturbed roadways.

Lotus corniculatus L. **Baja California**: Agricultural land NW of Meneadero, in turf of *Cynodon* at roadside, 10 m, 6 Sep 1980, *R. V. Moran 29207* (TEX).

This species is native to Eurasia and is an agricultural weed of concern because of the presence of cyanide compounds in the leaves. It is distinguished from other species of *Lotus* by its perennial and glabrous habit, 5 leaflets (3 at axil and the other 2 stipular in position), and solid stems.

LILIACEAE

Nothoscordum inodorum (Ait.) Nicholson **Michoacan**: Zitácuaro, entre Heroíca Zitácuaro y La Encarnación sobre la carretera Libre Federal No. 51, in roadside ditch, 6 Jun 1938, *G.B. Hinton 11936* (LL).

Native to South America and considered a noxious weed in California. This species is distinguished from other related Liliaceae by its perianth fused at the base into a tube (0.5–1 mm long), 6 fertile stamens with free filaments, and an absence of an onion-like odor.

MALVACEAE

Abutilon theophrasti Medik. **Sonora**: 9.5 km west of Resturante Puerto de la Cruz on Mex. 16 (km 258 E of Cd. Obregon), north side of Mesa el Campanero, oak woodland (28° 22' 15" N, 109° 03' 59"W), 1460 m, solitary annual in disturbed soil near corral, 12 Sep 1999, *T.R. Van Devender 99-499* (TEX). Det. P. Fryxell.

This species is native to southern Asia. It is distinguished from other species of *Abutilon* by its annual habit, leaves 10–20 cm wide, and capsules breaking up into more than 10 segments.

MORACEAE

Morus alba L. **Coahuila**: Las Rusias, Rio Santa Maria, carr. Muzquiz-Boquillas del Carmen, ca 10 km al NW de Muzquiz (28° 00' N, 101° 40' W), vegetation de huizache con *Baccharis neglecta*, 16 Sep 1992, *J.A. Villarreal 6922* (TEX). **Sonora**: Maicoba, Jul 1958, 5000 ft, *C. Pennington 213* (TEX). **Tamaulipas**: Nuevo Laredo, Reynosa street, 27 Mar 1964, *K. Peterson 56* (TEX).

Native to China, widely cultivated and escaping to riparian areas. *Morus alba* is distinguished from the Mexican species of *Morus*, *M. microphylla* Buckl. and *M. celtidifolia* Kunth, by its non-reticulate leaf surface, entire to densely lobed leaves (vs. entire), and much longer petioles (Correll & Johnston 1970; Standley 1920-1926). The specimen from Tamaulipas is obviously cultivated but is included here because of its proximity and potential to spread along the Rio Grande.

PAPAVERACEAE

Fumaria officinalis L. **Sonora**: Along the banks of the Rio Magdalena, cottonwood willow gallery (30° 37' 52" N, 110° 58' 20" W), 750 m, 8 Mar 1998, *A.L. Reina G. 98-169* & *T.R. Van Devender* (TEX).

POACEAE

Chloris barbata Sw. **Veracruz**: Weed association on low roadside (XAL).

Although no specimens of this species were examined by the present author, the taxon has been reported collected from Veracruz.

This species is native to Africa and it has been reported as introduced in Costa Rica (Manual de Costa Rica). It is distinguished from the other species of *Chloris* by its 4–20 spikes and 2 rudimentary florets.

Panicum coloratum L. **Nuevo Leon**: Mpio. Salinas Victoria, Rancho Cieneguillas 5 km al SE de Mamulique, grassland, 1 Oct 1999, *J. Valdes Reyna 2576* (TEX). Det. J. Valdes Reyna

Setaria pumila (Poir.) Roem. & Schult. **Nuevo Leon**: Mpio. Galeana, La Cuesta, 1850 m, grassy roadside, 20 Oct 1989, *Hinton 19886* (TEX); Mpio. Aramberri, N of Aramberri, 1000m, by stream, 23 Nov 1989, *G.B. Hinton 19962* (TEX). **Sonora**: Mpio. Yecora, Río Maycoba, at Méx 16 (20.5 km W of Maycoba, 28.6 km E Yécora), along roadside, 1220 m, *T.R. Van Devender et al. 97-797* (TEX); NE edge of Imuris along Méx 2, 885 m, cultivated fields and pasture, 15 Sep 2000, *T.R. Van Devender et al. 2000-705* (TEX). Det. J.R. Reeder

This species is native to Europe. It is distinguished from other species of *Setaria* by its annual habit and spikelets 2.8–3.5 mm long x 1.5–2.0 mm wide that are subtended by 4–15 bristles.

ROSACEAE

Pyrus communis L. **Chihuahua**: Sierra de los Hechiceros, Cañón Encampanado, below (E of) Rancho Encampanado and above (W of) jct. with Cañon de Indio (29° 40' 30" N, 103° 36' W), canyon-bottom woods with perennial stream in dry igneous mountains, planted but surviving without cultivation, 27 July 1974, *T. Wendt & A. Adamcewicz 437* (TEX).

Although this species was reported as cultivated, the fact that it has survived in the absence of cultivation warrants its inclusion as a persistent non-native.

RUTACEAE

Ruta graveolens L.

The Mexican database (XAL & IEB) lists 18 specimens of *Ruta graveolens* from nine Mexican states. There was one specimen identified as *R. graveloens* from TEX but upon further inspection the specimen was noted to be a misidentified specimen of *R. chalapensis* L. *Ruta chalapensis* is identified as having fringed petals versus entire in *R. graveolens*. Further examination of the specimens from XAL & IEB may reveal them to be *R. chalapensis*.

SCROPHULARIACEAE

Verbascum blattaria L. **Chihuahua**: Mpio. Villa Acuña, Rancho El Rincón, on SW of Serranias del Burro (part of Sierra del Carmen), ca 80 km SE of Big Bend National Park, Texas (28° 40' N, 102° 15' W) 1400-2100 m, 11 Jul 1992, *S. Aguilar Ruiz 288* with *D.L. Doan-Crider* (TEX).

This species is distinguished from the other alien species of *Verbascum*, *V. virgatum* Stokes, by its glabrous leaves and lower pedicels 10–15 mm long.

SIMAROUBACEAE

Ailanthus altissima (Mill.) Swingle **Chihuahua**: Along road between Creel-La Bufa road and Basiguare, along arroyo, 5325 ft, 17 Oct 1972, *R. Bye 3006* (TEX). **Coahuila**: Monclova, Gloria Mts., 20 May 1936, *E.G. Marsh 1846* (TEX).

ULMACEAE

Ulmus pumila L. **Nuevo Leon**: Mpio. Galeana, ranch ca 5 mi W of San Rafael, near Ejido El Milagro, well watered area (from wells), large trees, cultivated, 1800 m, 25 Sep 1994, *G. Nesom s.n.* (TEX); Mpio. Galeana, Rancho Aguililla, 1850 m, Aug 20 1994, *G.B. Hinton 24720* (TEX).

Based on the collection dates these are relatively recent introductions to Mexico, and although the specimens are cultivated in Mexico the species is here included in the alien flora because of its aggressive and weedy nature in Texas.

VERBENACEAE

Verbena brasiliensis Vell. **Nayarit**: Wet meadows near the highway, 12 miles SE of Tepic and nearly S of Cerro Sangangüey, 1000 m, 16-18 August 1959, *C. Feddema 583* (TEX). Det. H.N. Moldenke. **Nuevo Leon**: Raices, Allende, 290 m, 19 May 1994, *G.B. Hinton 24171* (TEX); Santiago, La Botella, 1280 m, dry stream bed, 16 June 1994, *G.B. Hinton 24343* (TEX).

Vitex agnus-castus L. **Nuevo Leon**: Montemorelos, 1600 ft, 7 Aug 1970, *D. Etchinson 55* (TEX). Det. H.N. Moldenke.

This species is known as an aggressive alien in many parts of the world, including Texas. It is readily identified from other Verbenaceae by its shrubby habit, aromatic and palmately lobed leaves and sprays of blue flowers.

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Jercinovic, E. 2010. From farming to floristics: William C. Martin (1923–2010). Phytoneuron 2010-4: 1–5. (10 March)

FROM FARMING TO FLORISTICS: WILLIAM C. MARTIN (1923 – 2010)

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Call it destiny, or serendipity, that soft force which propels a person from universally uncertain beginnings to a life's work. It is mostly uncontemplated, at best ill-defined. Yet somehow the gathering of experiences creates some sense of purpose and direction. Sometimes it takes a man from the simplest agrarian background to a formal career in science. So it was with Bill Martin, University of New Mexico professor and author.

William Clarence Martin was born on November 27, 1923 in Dayton, Kentucky, a small town across the Ohio River from Cincinnati. A brother, Eugene, was born on October 14, 1925. Their father, William Clarence Martin Sr., worked in an office supply company spray-painting office furniture. In 1927 the family moved to Ripley County in southeastern Indiana to build a new life on a farm of 100 acres about a mile south of Delaware, Indiana. "Ours was a fairly typical farm, with horses, mules, beef cattle, milk cows, hogs, and chickens. Dad raised all manner of vegetables, plus corn, soybeans, hay, oats, buckwheat and tobacco." Bill and his brother had numerous farm chores, from milking the cows to picking hornworms from the tobacco plants.

A common view in the agricultural Midwest in this era was to get education out of the way before boys grew big enough and strong enough to be of real use on the farm. His mother, Alline Ormes Martin was instrumental in his early education. "I started school a few months before I turned five, but I was at least somewhat prepared for school work, because Mom had taught me to read in our McGuffey Eclectic Reader when I was barely four." His first school was a one room rural "little red schoolhouse," made of brick, called Union School, complete with inkwells in the right hand corner of the desks. The restrooms were outside, side by side. Bill spent five years at Union School. In 1933 the family moved to a much smaller farm near Delaware. Bill entered the Delaware Grade School which contained grades one through eight. This school was considerably more formal than the Union School. He remained there until a Ripley County consolidated high school was completed in 1936 in Napoleon, about 8 miles from Delaware. At this point in his life, Bill showed little interest in science. In fact he was a charter member of Future Farmers of America at his new school. He graduated with twenty others in 1941.

Meanwhile, Bill did his part on the family farm. Life was still quite simple there. "I prepared all my homework by the light of kerosene lamps until I was a junior in high school." In 1937, the Martins relocated to another farm "a couple of miles northeast of Delaware." In 1939, there was another move to a farm complete with a running stream called Castetter Creek, a bit west of Delaware. Bill and his brother delivered newspapers and made extra money at 75 cents a week. After 1939, Bill and his father worked at the Milan Furniture Factory, about 5 miles away. Bill

worked as an apprentice on the molding machine starting out at 20 cents an hour. Even with school, the newspaper route, the furniture factory and the farm, Bill found time to hunt fossils and gather ginseng roots, which sold for $16 per pound.

During his last two years of high school, Bill saved enough money to pay part of his way to attend college. In the fall of 1941 he enrolled at Purdue University with the intention to study horticultural science. Pearl Harbor changed everything. By the fall of 1942 Bill realized that military service was inevitable. Early in 1943 he tried enlisting in the Marines and the Navy, but for both the quotas were full. The army had no quotas and in the late winter of 1943 he was inducted into the U.S. Army at Ft. Benjamin Harrison near Indianapolis. Two weeks later he was sent to Camp Swift near Austin, Texas for basic training. He was assigned to the 389th Field Artillery Battalion in the 97th Infantry Division. After basic training his unit moved on to field maneuvers in "the piney woods and swamps of Louisiana." Shortly thereafter he was transferred to the Army Specialists Training Program for engineering training at Louisiana State University and then to the College of Mines and Metallurgy (now UTEP) in El Paso, Texas. By the summer of 1944 the army decided it wouldn't continue the ASTP program and Bill rejoined his old unit in Ft. Leonard Wood in Missouri. Bill signed up to become a paratrooper, but was picked to go to aerial defense machine gun school in South Carolina. After returning to Missouri the army gave Bill his first taste of teaching. "So the army people assigned me to the instructor's hand to hand combat school…After training, my assignment was to instruct our unit, a class of about 175 — guys all bigger than me — to the finer points of hand to hand combat, including knife fighting. I guess I had learned the techniques sufficiently, because I had to show a lot of big guys that a little fellow like me could defend himself." Anyone who knew Bill would find this unimaginable.

Bill's unit was ordered to Camp San Luis Obispo, California for amphibious warfare training in preparation for duty in the South Pacific. The men took initial training there and then were sent to other camps in southern California to be trained in the use of landing craft. After training had been completed, the army decided the unit was needed in the European theater. In February 1945 they reached the east coast and two days later left on the 12 day Liberty Ship journey to Europe, arriving at Le Havre, France in early March. The 97th moved north through Belgium and entered Germany near Aachen. They tasted their first action on the west bank of the Rhine River. "It was there, after the German shells began dropping in, I became one of the fastest foxhole diggers anyone has ever seen." Bill's duty initially was as a .50 caliber machine gunner and an anti-tank gunner. Later he was assigned to the laying and repairing of battlefield phone lines. "That meant that we might have to crawl along in mud or snow toward an observation post, in pitch darkness, with a telephone line in one had and a rifle in the other, all the time looking for a break in the line. Often German and American machine gun fire and mortar bursts were too close for comfort." Bill also helped to detect and clear land mines. The 97th had become part of Patton's 3rd Army and took part in the Battle for the Ruhr Pocket which resulted in the surrender of thousands of German soldiers. "During that action, we fired night and day, three howitzer rounds per minute." As spring advanced, the army swiftly moved across Germany and into Czechoslovakia. By mid-May the shooting was over in Europe.

Bill's unit returned to the United States and the men were given 30 days furlough with the understanding that they would reassemble and participate in the invasion of Japan. The men reported to Ft. Bragg, North Carolina for additional training. They then boarded a train for a seven-day trip to Ft. Lawton near Seattle where the 97th was assembling. However almost every man in Bill's battalion – the 389th – came down with amoebic dysentery and the 97th left without them. The 389th was broken up and given stateside duty. Bill was discharged from the army on Valentine's Day, 1946. He had lost one uncle in combat, and another uncle and his brother were seriously wounded.

Bill's last duty station was at Camp Atterbury about 20 miles south of Indianapolis, Indiana. After he left the army he was only about 50 miles from Middletown in Henry County, where his parents were living. He stayed with them for a time and then decided to hitchhike to see his brother at Ft. Sam Houston in San Antonio, Texas. His brother, Eugene was still in the army after being wounded in Europe. After returning to Middletown, he took a trip back to his old haunts in Ripley County to visit old friends and families. He made a special point of seeing a girl named Evelyn Hastings who had lived on a farm sharing a fence with the Martin farm when Bill was in high school. He even went to Easter Sunday services at her church on April 21. By the end of spring, Bill had made the decision to return to Purdue in the fall.

By September, he was back in West Lafayette enrolled in the Division of Forestry of the School of Agriculture of Purdue University. He soon switched to the Department of Horticulture. After rooming with relatives for a while, he bought an old house in Lafayette, where he and a few other students lived. On June 14, 1947 he and Evelyn Hastings were married. The newlyweds continued to live in Bill's house with four others. Bill and Evelyn both worked at Sears to provide income. Their first child, William David, was born in 1949. Bill graduated in 1950 with a degree in horticultural science.

Bill landed a job with Smith Nursery in Muncie, Indiana. They sold their house in Lafayette and bought another in Middletown, about 12 miles from Muncie. Bill worked at the nursery for about a year and then got into managing apple orchards. It wasn't the most lucrative of occupations so he went to work for General Motors in a plant that produced automobile lighting equipment. He then joined the Allison Aircraft Engine division in Indianapolis. The long drive to Indianapolis became wearisome and he went to work at the Kaiser-Willis Company in Anderson, Indiana, which manufactured gears for jet engines and automatic transmissions. The plant closed its operations in 1954. Bill needed to make another change. "For a long time, I had wanted to embark on a career in biological science and this seemed to be a perfect time to make a clean break with automobile and aircraft production. So I applied to the Indiana University Graduate School for advanced studies in botanical sciences."

So at age 30 Bill, with Evelyn and by this time their three children David (William), James and Barbara, moved to Bloomington, Indiana. Bill held a teaching assistanceship and Evelyn worked full time at a dry cleaning establishment. "Those were really busy years for both of us, early morning to midnight everyday." Since his interest was taxonomic botany, he studied under Dr, Charles Heiser, a renowned sunflower specialist. Bill also served as curatorial assistant at the herbarium. As part of his research, he made numerous field forays all over the south-central and southeastern states collecting sunflowers. He completed his Masters in 1956 and his Ph.D. in 1958, with his dissertation on the Biosystematics of *Helianthus angustifolus* and Related Species.

Bill sent out applications for employment to several schools. He decided to accept a position at the University of New Mexico. He had been through the area on troop trains during the war. The west was new and different, a treasure trove for a botanist with a passion for floristics. "It was a change. I don't think that Evelyn was particularly thrilled when we came through the canyon. She was a little shocked I'm sure, but after we'd been here a year or so we had no wish to return to the east anymore." Bill quickly became immersed in teaching as well as learning about the geography and the plants of New Mexico. He got to know the faculty. One member, at that time the longest serving member of the Biology Department in the school's history, Dean of the Graduate School, and Vice President of the University, was Dr. Edward Castetter, a curious reminder to Bill of his youth along Castetter Creek in Ripley County.

In 1961, Castetter retired from his extensive administrative responsibilities at the University. Bill worked with Castetter a great deal. He often assisted with proofreading. The two produced *A Checklist of Angiosperms and Gymnosperms of New Mexico* in 1970. After retiring, Castetter still had two major projects he wished to complete: a complete treatment of the cacti of New Mexico and the preparation of a new flora of the state. He decided to devote his time to the study of cacti and suggested that Bill undertake the project of writing a new flora of New Mexico. Bill involved his graduate students in gathering floristic data and used his summers to explore the state (and the southwest in general) for plants. In the summer of 1965 Bill, with Loren Potter from UNM, Dale Smith from the University of California, Santa Barbara, and Neil Osborne from the University of Southern Colorado operated a summer field botany institute for advanced graduate students at UNM's D.H. Lawrence Ranch near Taos, New Mexico. In 1967, Bill and Dale Smith spent the summer studying alpine phlox in the central and southern Rocky Mountains. In 1968 a man by the name of Charles R. "Bob" Hutchins, whom Bill had gotten to know through the American Association for the Advancement of Science (AAAS), moved to Albuquerque to pursue an advanced degree under Bill. Bob rapidly became absorbed in the flora project, and though he did not choose to complete his studies, became Bill's close friend and dedicated himself to the project for the next twelve years. It is hard to conceive of the difficulty of this undertaking. There were no computer databases. Everything was done with paper, pencil, typewriter, and file folders.

Bill served as Assistant Professor of Biology from 1958-1965, Associate Professor of Biology from 1965-1971, and Professor of Biology from 1971-1989, as well as Curator of the Herbarium from 1958-1989. During a leave of absence from UNM he served as Senior Curator of Botany at the Los Angeles County Museum of Natural History from 1970-1972. At the same time he was Adjunct Professor of Biology at the University of Southern California. He remained a Research Associate at the Museum of Natural History for the remainder of his career.

After returning to UNM in 1972, Bill worked on a diversity of projects, numerous botanical surveys, the chemotaxonomy of *Ribes*, the chemotaxonomy of *Astragalus* and *Oxytropis,* natural succession on strip-mined land, and germination requirements of plants of arid lands. Of course, considerable energy went into the effort to finish the flora of New Mexico project. By the late 1970's most of the research was as complete as possible for a continuously evolving topic. Bill began assembling the massive document. "The typing was awfully time consuming. I'd come home to supper and go back to work and type a while."

The prospect of finding a publisher was daunting. Bill tried to involve UNM Press, but the task was too large and the audience too small to pique their interest. Undaunted, Bill typed on, while Bob Hutchins prepared range maps. Clayton Hoff, a parasitologist in the department would get together with Bill every morning to proofread. Somehow, by some route unknown to Bill, J. Cramer, a German publisher, heard about the project and contacted Bill. Bill, Bob, and everyone associated with the flora were ecstatic. For the next year and a half sections of the flora were mailed to Germany by "Santa Fe Bill," as he was affectionately known at J. Cramer. There was no email. There were no word processors. "That was a challenge. Sent it in sections, usually a hundred or two hundred pages at a time. But there were 2600 pages all together. Took a lot of mailing back and forth, a lot of postage." The *Flora of New Mexico*, in two volumes, appeared in 1980-81. Bill and Bob agreed that their final product was not all they had wished it to be. There were omissions and errors, but after so many years, there simply wasn't the energy to pursue the project further.

Over the years, Bill taught 19 different classes. He came to be known among his students as "P.C.," plant chief. He advised more than 60 graduate students involved with monographic studies of *Castilleja, Senecio*, and *Cirsium,* and floristic studies of the Jemez Mountains, Redondo Peak, Mt. Taylor, the Manzano Mountains, Wheeler Peak, the San Andres Mountains, the Animas Mountains,

the Ladron Peak/Sevilleta area, the Datil Mountains, and the Grants lava beds. During the 1980's, Bill continued his association with Bob Hutchins, publishing three books in conjunction with Robert DeWitt Ivey: *Spring Wildflowers of New Mexico* (1984), *Summer Wildflowers of New Mexico* (1986), and *Fall Wildflowers of New Mexico* (1988). Also, in this decade, Bill and Loren Potter put together a summer course for graduate students to study and collect plants in the western U.S. The group logged more than 5000 miles in eight states. Bill also continued his connection with the Los Angeles County Museum, making several visits to the Hawaiian Islands to study rare and endangered plants. These forays were to backcountry areas to the islands of Hawaii, Oahu, Maui, Kauai, and Molokai. Bill noted" We were able to locate some plants that had not been seen for 50 years or more." While there, he was able to reconnect with an ex-student who earned a Masters at UNM, Warren L. Wagner, then Associate Botanist at the Bishop Museum in Honolulu.

Late in his career he and Evelyn purchased 31 acres of ponderosa forest land in Grant County, a few miles north of Silver City. "Early in our marriage, I promised Evelyn a 'cabin in the woods.' Now that we had the woods, it seemed logical that we should have the cabin." Bill retired from the University in 1989. Soon thereafter Bill and Evelyn designed an 860 square foot cabin. Construction, plumbing, and wiring were effected by the family. Bill, Evelyn, son Dave and daughter-in-law Dottie, daughter Barbie and son-in-law Dan, and son Jim all worked on it, mostly with the use of hand tools. Away from academia, Bill remained active. For a number of years he served on the botanic garden advisory committee, which gave rise to the Rio Grande Botanic Garden. He also served on the La Semilla Advisory Council for the New Mexico State Land Commissioner, Dr. Ray Powell. Bill gave numerous lectures about wildflowers and many other subjects to various community groups. The Martins became very interested in their family histories and began serious genealogical research, including trips to Canada and London.

The twilight of any career is necessarily bittersweet. Bill's retirement was probably longer than many – more than 20 years. He was as active as he could be, but time passed. He retained an essential joy in what he had contributed, particularly to those he had sought to educate and motivate in his many years of teaching. Indeed, his graduate students have contributed much. Warren L. Wagner became curator of the National Herbarium at the Smithsonian Institution and world expert in the family Onagraceae (evening primrose) as well as President of the American Society of Plant Taxonomists. Ray Powell served two terms as Land Commissioner of New Mexico and is now Director of the Jane Goodall Institute's Root and Shoot Program. Reggie Fletcher spent a distinguished career with the U.S. Forest Service. Paul Knight spent 12 years as botanist for the New Mexico Natural Heritage Program. There are many others. In his last decade he was honored with the naming of *Cirsium ochrocentrum* var. *martinii*. Although he would never have really supported the naming of a plant for himself, there is little doubt that he was touched by the gesture of UNM Ph.D. candidate Patricia Barlow-Irick.

Bill died quietly in his sleep on January 18, 2010.

Leoschke, M.J. 2010. *Liparis loeselii* (Orchidaceae) new to South Dakota. Phytoneuron 2010-5: 1–3. (10 March)

LIPARIS LOESELII (ORCHIDACEAE) NEW TO SOUTH DAKOTA

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ABSTRACT

Liparis loeselii is new to the flora of South Dakota. It is documented here from three sites in Roberts County and reported without vouchers from two other sites in Roberts and Day counties. The collections are from the Prairie Coteau, a Pleistocene plateau of glacial moraines.
KEY WORDS: *Liparis loeselii*, fen, Prairie Coteau, South Dakota, wet meadow

Liparis loeselii (L.) L.C. Rich. (Loesel's twayblade, green twayblade or yellow widelip orchid) is a native orchid in North America found primarily in the north-central and northeast United States plus eastern Canada, with scattered populations in the southeast and western United States plus western Canada (Kartesz 2010). It is also found in Europe (Magrath 2002; Rolfsmeier 2007). *Liparis loeselii* has a swollen pseudobulb with a pair of elliptic to oblong, pale green basal leaves, and a raceme with pale green or yellow-green flowers. It can reach heights of up to 26 centimeters, but is generally much shorter. *Liparis loeselii* occurs in a range of mesic to wet, calcareous to acidic plant communities including mesic to wet tallgrass prairie, wet meadows, alder thickets, seeps, lakeshores, poor and rich fens as well as moist ditches, old fields, abandoned pastures, old sand pits and other disturbed, moist to wet habitats. The orchid's populations tend to decrease if open habitats are invaded by woody plants over time. The green color and normally rather short stature of *Liparis loeselii* makes it easy to overlook in taller vegetation.

Liparis loeselii has previously been documented from most states bordering South Dakota including Iowa (Niemann 1986), Minnesota (Ownbey et al. 1991; Smith 1993), Montana (Rolfsmeier 2007), Nebraska (Kaul et al. 2006) and North Dakota (Larson 1993; Stevens 1963). The orchid is not reported from South Dakota in the most recent floras covering the state (Great Plains Flora Association 1986; Larson 1993; Van Bruggen 1996). This paper documents the discovery of *Liparis loeselii* in Roberts and Day counties in the northeast corner of South Dakota. The collections and observations are from the Prairie Coteau, a Pleistocene plateau of glacial moraines, which occurs in extreme southeast North Dakota, far eastern South Dakota, far southwest Minnesota and a small area of northwest Iowa. The sites mentioned in this paper are in an area of late Wisconsin glaciation. Much of the far north portion of the Prairie Coteau in northeast South Dakota consists of rolling tallgrass prairie pasture, lakes, marshes, wet meadows and fens plus areas of deciduous forest associated with ravines and adjacent slopes.

Liparis loeselii has been vouchered from three sites in Roberts County. Specimens have been or will be deposited in the Charles A. Taylor Herbarium (SDC) at South Dakota State University in Brookings, South Dakota. Soil names are from Miller et al. (1977):

Site 1. T122N R51W Section 5 NW4 SE4 SE4 SW4. Approximately 4.7 miles north/northwest of the north edge of Summit. A rich fen occurs in a prairie pasture on the south side of a drainageway that flows west into a marsh. The soil is mapped as Marysland silt loam, wet (Mw), a Typic Calciaquoll, but is actually muck.

Liparis loeselii is infrequent and occurs in an area of less than 100 square meters. The flowers are light green and just beginning to bloom. *Liparis loeselii* is associated with *Caltha palustris*, *Carex aquatilis*, *Carex utriculata*, *Eupatorium maculatum*, and *Lysimachia thyrsiflora*. 28 Jun 1996. Voucher: *Leoschke 1624*.

Site 2. T127N R52W Section 31 NW4 SE4 NE4. An approximately 5+ acre calcareous fen, raised about 4 meters above the surrounding land, occurs in a prairie pasture about 9 miles northwest of Sisseton. A smaller calcareous fen (less than 0.3 acre) occurs north of the northwest corner of the large fen. The fens are southeast of Sica Hollow State Park. The soil in the large fen is mapped as Rauville mucky silt loam, 0 to 2 percent slopes (Ra), a Cumulic Haplaquoll. The soil in the fens is actually muck.

Liparis loeselii is infrequent in both calcareous fens. It occurs as dry infructescences with basal leaves that are withered and mushy. In the large fen the plants are found at the north/northwest edge of a large pool in a sedge mat zone. *Liparis loeselii* is associated with *Aster junciformis*, *Carex* sp., *Eleocharis pauciflora*, *Lobelia kalmii*, *Muhlenbergia glomerata*, *Scirpus acutus*, and *Triglochin palustris*. 7 Nov 1996. Voucher: *Leoschke 1778*.

Site 3. T127N R52W Section 31 N2 SE4. A disturbed, approximately 0.5 acre calcareous fen occurs in a drainageway in a tallgrass prairie pasture approximately 9 miles northwest of Sisseton.

Liparis loeselii is infrequent and has light green flowers. It is associated with *Carex hystericina*, *Carex interior*, *Carex pellita*, *Carex prairea*, *Glyceria striata*, *Triglochin palustris*, and *Viola nephrophylla*. 25 Jun 2009. Voucher: *Leoschke 2823*.

I observed *Liparis loeselii* at two additional sites in Roberts and Day counties that were not vouchered (Day County is just southwest of Roberts County):

Site 4. Roberts County T124N R52W Section 23 N2 NE4. *Liparis loeselii* is infrequent in a narrow band of wet meadow above a rich fen. The soil is mapped as Parnell silty clay loam (Pa), a Typic Argiaquoll. *Liparis loeselii* is associated with *Agrostis gigantea*, *Caltha palustris*, *Carex interior*, *Helenium autumnale*, *Muhlenbergia glomerata*, *Lobelia kalmii*, *Viola nephrophylla*, and *Zizia aurea*. 16 Aug 1996.

Site 5. Day County T123N R53W Section 16 SW4. *Liparis loeselii* is infrequent in a rich fen south of the headquarters road in the Waubay National Wildlife Refuge. 12 Sep 1996.

Voucher Summary USA. South Dakota. Roberts Co.: ca. 4.7 mi (7.5 km) NNW of the N edge of Summit, T122N R51W Section 5 NW4 SE4 SE4 SW4, infrequent in rich fen in prairie pasture on S side of drainageway that flows W into marsh, 28 Jun 1996, *Leoschke 1624* (SDC); ca. 9 mi (14.5 km) NW of Sisseton, SE of Sica Hollow State Park, T127N R52W Section 31 NW4 SE4 NE4, in 5+ acre (2 ha) calcareous fen in prairie pasture, 7 Nov 1996, *Leoschke 1778* (SDC); ca. 9 mi (14.5 km) NW of Sisseton, T127N R52W Section 31 N2 SE4, in disturbed ca. 0.5 acre (0.2 ha) calcareous fen in tallgrass prairie pasture, 25 Jun 2009, *Leoschke 2823* (SDC).

Conservation *Liparis loeselii* has a rank of S1 in a list of rare plants maintained by the South Dakota Natural Heritage Program (Ode 2009). This rank indicates the species is critically imperiled because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction. The primary threat to *Liparis loeselii* in South Dakota is the destruction or alteration of its wetland habitat.

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Holmes, W.C. and H.J. Blizzard. 2010. The derivation of the name *Datisca* (Datiscaceae). Phytoneuron 2010-6: 1–2. (10 March)

THE DERIVATION OF THE NAME *DATISCA* (DATISCACEAE)

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ABSTRACT

The name *Datisca* is attributed to Dioscorides in *de Materia Medica*, where it was cited as a Roman common name for species of *Catananche* (Asteraceae). Linnaeus apparently appropriated the name from Dioscorides but used it for species of a different genus and family. The derivation of the original name remains unknown.
KEY WORDS: *Datisca*, Datiscaceae, Dioscorides, *de Materia Medica*.

The Datiscaceae, as it will be treated in the Flora of North America, consists of a single genus of perennial herbs, *Datisca*, composed of two species. These are *D. cannabina* L. of southwest Asia from the eastern Mediterranean to the Himalayas and *D. glomerata* (C. Presl) Baillon of California, extreme western Nevada (near Lake Tahoe) of the southwest United States, and Baja California Norte, Mexico.

Interest in the derivation of the name *Datisca* originated with the preparation of a treatment of *Datisca glomerata* for the Flora of North America North of Mexico project. The etymology of generic names is a required entry in the generic descriptions. The present manuscript is intended to supplement the brief statement on the derivation that will be presented there.

Few references were found on this topic, possibly a reflection of the small size and lack of economic importance of the family. Stone (1993), in a treatment of *Datisca glomerata* for *The Jepson Manual*, merely stated "derivation unknown." In a treatment of *Datisca cannabina* L. in *Flora of the U.S.S.R.*, Gorshkove (1949), gave the following etymology: "from Greek *datessai* – to heal and *iskeiv* – to equate. The aerial parts of the plant are used internally in Italy for treatment of gastric, scrofulous, and other complaints." Lacking other comments, this explanation seemingly implied that the name *Datisca* was created by Linnaeus, which it was not. He also failed to mention that the name, as used in the original source, referred to two (or more) species. Despite the passing of 257 years since Linnaeus's use of the name, the etymology of *Datisca* has remained unresolved.

The name *datisca* was discovered by Blizzard in an English translation of *de Materia Medica* (Osbaldeston & Wood 2000), originally written in 64 CE by the Greek physician and botanist Pedanius Dioscorides (40–90 CE). The name is included in the treatment of the plant *Katananke* (or *Catanance*) in Book 4-134, where it is cited as a Roman common name.

The suggested identity of *Katananke* is not the genus *Datisca* but either *Catananche graeca* L. or *C. caerulea* L. (Asteraceae). Neither species of *Catananche* resembles *Datisca cannabina*, a name suggesting similarity to *Cannabis sativa* L. The name *datisca* was later applied by Linnaeus (1753) to the genus now known as *Datisca*. The statement by Dioscorides that *datisca* is a common name used by the Romans only gives the source of the name used by Linnaeus, not the origin of the word itself. In short, the *datisca* of Dioscorides and the *Datisca* of Linnaeus and Gorshkove (1949) are different plants. The word *datisca* itself, as used by Dioscorides, is best considered to be of unknown origin.

Linnaeus (1753) apparently borrowed names liberally from *de Materia Medica* for inclusion as generic names in *Species Plantarum*. For example, the name of nearly every plant Dioscorides treated in Book 4 was used by Linnaeus as a generic name in *Species Plantarum*. Many of the local common names were also used by Linnaeus as generic names, a good example being *datisca*. Others include *salix* (under 4-46, *ippouris*), *vaccinium* (under 4-63, *uakinthos*), *ricinis* (under 4-164, *kroton e kini*), etc. Dioscorides often gave the source of these names (such as the Magi [magicians, "wise" men], Romans, Africans, Egyptians, Persians, Gauls, etc.). Probably due to general unavailability of *de Materia Medica*, the name *datisca* has remained undiscovered for over 1900 years in one of the most successful medical books of all time.

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LeBlond, R.J. 2010. The type specimens of *Panicum roanokense* (Poaceae). Phytoneuron 2010-7: 1–4. (10 March) Mailed 13 May 2010.

THE TYPE SPECIMENS OF *PANICUM ROANOKENSE* (POACEAE)

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ABSTRACT

Four specimens at NCU originally determined by W.W. Ashe to be *Panicum roanokense* have been designated as the holotype, an isotype, and two paratypes. Two of the three specimens identified as *Panicum roanokense* in the U.S. National Herbarium Type Register have been determined not to be types, while the third specimen is confirmed to be a paratype, as currently designated.

An examination of collections of *Panicum roanokense* Ashe at the U.S. National Herbarium (US) and University of North Carolina Herbarium (NCU), where many of Ashe's original collections are housed, has resulted in new designations and changes in designations of holotype, isotype, and paratype specimens for this taxon now treated as *Dichanthelium dichotomum* (L.) Gould subsp. *roanokense* (Ashe) Freckmann & Lelong (2002) in Freckmann and Lelong (2003), and *D. dichotomum* var. *roanokense* (Ashe) LeBlond (LeBlond 2001) in Weakley (2010). These changes are made in accordance with data in the protologue (Ashe 1898) and Hitchcock and Chase (1910) and are summarized in Tables 1 and 2.

Ashe based his new species on specimens he collected in North Carolina at Roanoke Island in Dare County, and at two sites near Lake Mattamuskeet in Hyde County. In the protologue, Ashe wrote: "Type material collected by writer in dry soil, Roanoke Island, N.C. June, 1898; also collected at Rose Bay and Mackleyville, N.C., the same month."

In their 1910 treatment of *Panicum roanokense*, Hitchcock and Chase wrote: "The type could not be found in Ashe's herbarium. In the Biltmore Herbarium is a specimen from Manteo, Roanoke Island, N.C., collected by Ashe, June 10, 1898, and labeled by him as *Panicum roanokense* Ashe. This is a duplicate type or possibly the type." Regarding Ashe's personal herbarium, Hitchcock and Chase wrote: "Mr. Ashe kindly loaned a portion of the collection of *Panicum* in December, 1905. A second portion was sent in February, 1908. Certain of Mr. Ashe's type specimens were not included in either of those loans, but they may become accessible at some future time." Many of the panicums in Ashe's herbarium were received by NCU directly from his estate within a year of his death in 1932.

The Biltmore specimen studied by Hitchcock and Chase has not been relocated, but at NCU is an Ashe specimen (NCU 17962) labeled "*Panicum Roanokense* / type" (I have added the slash to represent a line break) in Ashe's handwriting. Printed on the label is "Plants of the Southern United States" in all caps, which is standard on Ashe labels. "W.W. Ashe, Collector" is also printed on the label, but there is no collection number (also standard for Ashe), no date (even year is missing), and no location data. It is the only specimen known to be designated by Ashe himself as a type for *P. roanokense* and is here regarded as the holotype, with collection and location data as stated in the protologue.

NCU specimen 17963 contains label information similar to that of the specimen Ashe designated as the holotype. Added in print is "on or near the coast of North Carolina June 10 – July 6, 1898." In Ashe's handwriting is: "*Panicum Roanokense* Ashe / Manteo." This label is typical of Ashe's dating method, showing a range of dates rather than a specific date. The location data, "Manteo," a town on

Roanoke Island, is a little more precise than in the protologue. This specimen is regarded here as an isotype even though the collection date is imprecise and the location somewhat vague. This is in keeping with the treatment of presumed "duplicate" types (isotypes) for other Ashe *Panicum* taxa by Hitchcock and Chase that continue to be accepted today, including those for *Panicum lucidum* Ashe, *P. mattamuskeetense* Ashe, and *P. maculatum* Ashe (a synonym of *P. yadkinense* Ashe).

The label data on NCU specimen 17963, the isotype, corresponds with that on the missing Biltmore Herbarium specimen cited by Hitchcock and Chase, except for the date, which they report was "June 10, 1898." This "date" may well have been similar to that shown on US specimen 722467 (discussed below). Ashe typically did not give an actual collection date but instead provided a range of dates corresponding with the beginning and end dates of the expedition, in this case "June 10 – July 6, 1898." In US specimen 722467, "July 6" is crossed out in ink, possibly by Ashe. The deletion of "July 6" on this label could suggest that "June 10" is the collection date, but since this is the beginning date of the range of dates on the label, that seems unusually coincidental, especially considering the absence of precise dates on Ashe labels in general. A specific date resulting from a striking out of one date in a range of dates should be regarded with suspicion, if not disregarded altogether. If the "June 10, 1898" date on the missing Biltmore Herbarium specimen resulted from the crossing out of "July 6" by Ashe himself, perhaps it was the month "July" he was eliminating, to correspond with the "June, 1898" collection date in the protologue. That may also have been the purpose of the cross-out in US specimen 722467.

NCU specimens 24095 and 356878 have labels nearly identical to that of NCU specimen 17963, differing only by location, with "Rose Bay" in place of "Manteo." These specimens are here regarded as paratypes, as Rose Bay is one of the three cited locations in the protologue.

In the US Type Register are three specimens identified as types for *Panicum roanokense*, one as an isotype (No. 722467), one as a "possible isotype" (No. 967961), and one as a paratype (No. 970167). Only the paratype appears to correspond with the interpretation of types regarded here as correct.

The label of US specimen 722467, annotated as an isotype, indicates it was collected by Ashe from Roanoke Island, with a printed date of "June 10 – July 6, 1898." As noted above, "July 6" is crossed out in ink. This specimen was originally annotated by Ashe as "*Panicum arenicolum* Ashe" (correctable to *P. arenicola*), and there is no later annotation by Ashe himself to *P. roanokense*. This rules out the specimen as an isotype, since Ashe did not consider it to be *P. roanokense* when he prepared the protologue. It was subsequently annotated to *P. roanokense* by Hitchcock and Chase during their revision of *Panicum* and was annotated as an isotype by R.J. Soreng in 2001. *Panicum arenicola* is a synonym of *Dichanthelium aciculare* Desv. ex Poir. var. *aciculare*. The spikelets in this specimen are 1.7–1.8 mm long and first glumes are 0.4–0.5 mm long, both shorter than those typical of specimens treated as *Panicum roanokense*. The plant is bluish- to purplish–green, and the panicle is narrow and short-exserted. These characters place the specimen in *Dichanthelium caerulescens* (Hackel ex Hitchcock) Correll, and I annotated it as such on 27 Aug 2001 (chronologically after Soreng). The basionym *Panicum caerulescens* Hackel ex Hitchcock was not described until 1909, and this specimen may well have been annotated by Hitchcock and Chase to *P. roanokense* prior to recognition of *P. caerulescens*.

US specimen 967961, annotated as a "possible isotype," is from the Biltmore Herbarium but is not the one cited by Hitchcock and Chase. It was originally labeled by Ashe in his handwriting as "*Panicum dichotomum*, Roanoke Island, N.C., June 1898." It was subsequently annotated as *Panicum dichotomum* L. by Hitchcock and Chase (1910) during their revision of *Panicum*. In 2001 (prior to Aug. 27), Soreng added the note "Possibly type material Panicum roanokense." On 27 Aug 2001, I annotated

the specimen to *Dichanthelium dichotomum* var. *roanokense*. Since this specimen was not regarded as *P. roanokense* by Ashe, it could not be among those specimens cited in the protologue as representing his concept of the new taxon.

US specimen 970167 was originally labeled by Ashe in his handwriting as "*Panicum roanokense* Ashe / Rose Bay," with the pre-printed date range of "June 10 – July 6, 1898." Handwritten above the label is the note "Same as *P. curtivaginum* Ashe / H&C," a name subsequently placed in synonymy with *P. roanokense* by Hitchcock and Chase. Soreng annotated the specimen as a paratype in 2001, and I annotated the specimen to *Dichanthelium dichotomum* var. *roanokense* on 27 Aug 2001 (chronologically after Soreng). The data handwritten by Ashe on this specimen correspond with the data in the protologue for Rose Bay, and this specimen is a valid paratype. It likely is from the same collection as paratype specimens Nos. 24095 and 356878 at NCU. Of interest, also appearing on the US sheet is the note "spikelet drawn / AC." On page 196 of the 1910 Hitchcock and Chase treatment of *Panicum* is an illustration of the *P. roanokense* spikelet with this caption: "From specimen collected by Ashe at Rose Bay."

Table 1. *Panicum roanokense* type specimens at University of North Carolina Herbarium (NCU). Specimens 24095 and 356878 have identical Ashe label data. The Ashe name is the name given to the specimen by Ashe himself. Under reannotations, the annotater's name and year of annotation is listed in parentheses.

	NCU specimen 17962	**NCU specimen 17963**	**NCU specimens 24095, 356878**
Ashe name	*Panicum roanokense*	*Panicum roanokense*	*Panicum roanokense*
Reannotations	*Dichanthelium dichotomum* var. *roanokense* (LeBlond 2008)	*Dichanthelium dichotomum* var. *roanokense* (LeBlond 2008)	*Dichanthelium**dichotomum* var. *roanokense* (LeBlond 2008)
Type	holotype	isotype	paratypes

Table 2. The status of specimens treated as *Panicum roanokense* types in the US National Herbarium Type Specimen Register. The Ashe name is the name given to the specimen by Ashe himself. Under reannotations, the annotater's name and year of annotation is listed in parentheses. Soreng annotations made in 2001 are earlier than those made by LeBlond in the same year.

	US specimen 722467	**US specimen 967961**	**US specimen 970167**
Ashe name	*Panicum arentcolum*	*Panicum dichotomum*	*Panicum roanokense*
Reannotations	*P. roanokense* (Hitchcock & Chase n.d.), Soreng 2001), *Dichanthelium caerulescens* (LeBlond 2001)	*P. dichotomum* (Hitchcock & Chase n.d.), *P. roanokense* (Soreng 2001), *Dichanthelium dichotomum* var. *roanokense* (LeBlond 2001)	*Dichanthelium dichotomum* var. *roanokense* (LeBlond 2001)
US type assignment	isotype	possible isotype	paratype
Type reassignment	not a type	not a type	paratype

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Hatch, S.L. 2010. *Urochloa subquadripara* (Poaceae: Paniceae) new to Texas and a key to *Urochloa* of Texas. Phytoneuron 2010-8: 1-4. (8 April)

UROCHLOA SUBQUADRIPARA (POACEAE: PANICEAE) NEW TO TEXAS AND A KEY TO *UROCHLOA* OF TEXAS

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ABSTRACT

Urochloa subquadripara is reported as introduced into Texas. A key to separate the 13 species of *Urochloa* in Texas is presented along with an image of the newly reported species.
KEY WORDS: Poaceae, *Urochloa*, Texas, introduced, invasive plant

Urochloa P. Beauv. is primarily a grass genus of Old World origin. Thirteen of the estimated 100 species (Wipff & Thompson 2003) worldwide occur in Texas. This genus was separated from closely related or similar Paniceae by Wipff et al. in 1993. *Urochloa* (Wipff & Thompson 2003) is described as having terminal and axilliary panicle inflorescences with 2 to several spicate primary unilateral branches. Spikelets are solitary, paired, or in triplets and occur in 1–2 (4) rows per primary branch. With 2 florets per spikelet, the upper floret is fertile, indurate and rugose to verrucose, the lower floret sterile or staminate. A key to three *Urochloa* species was published by Wipff et al. (1993).

Eight of the Texas taxa are introduced (five invasive) and five are native to North America. The introduced taxa are native to tropical or subtropical regions of the world and their points of introduction appear to be from the coast or south Texas and following a period of adaptation move inland and/or to the north.

Urochloa subquadripara (Trin.) R.D. Webster has recently been collected in south Texas (Hidalgo County). The specimens were identified (Wipff & Thompson 2003) and verified using specimens in the S.M. Tracy Herbarium (TAES) at Texas A&M University.

This new introduction to Texas is recent. Taxonomic keys had not keyed or described *Urochloa subquadripara* in the United States (Hitchcock 1935). Hitchcock (1951) gave mention of the species without including it in the key, stating that it is occasionally planted in Florida as a potential forage crop. Later, Hall (1978) and others, including Wunderlin (1982) and Wipff and Thompson (2003) have included the species in descriptions and keys. Más and Garcia M. (1990) discussed the occurrence of the species in Puerto Rico and reported it to be a good forage.

Urochloa subquadripara was not reported as being found in Texas by Gould (1975) and others, including Hatch et al. (1990), Fox and Hatch (1996), Wipff et al. (1993), and most recently Jones et al. (1997). Following are the species description, voucher information, and a digital image of *U. subquadripara*, and a key to *Urochloa* of Texas.

Urochloa subquadripara (Trin.) A. Hitchc., Lignan Sci. J. 7: 214. 1931. TROPICAL SIGNALGRASS.

Fig. 1. Creeping annuals or short-lived perennials. **Culms** 40 cm long, apex erect, decumbent and rooting at nodes, nodes glabrous. **Leaves** mostly cauline. **Sheaths** terete, shorter than internodes. **Ligules** ca 1–1.3 mm long, a ciliate membrane. **Blades** to 25 cm long, 4–11 mm wide, flat (thin), glabrous or pubescent, margins not crisp. **Panicles** of 3–8 spicate primary unilateral branches; branches to 9 cm long (Fig. 1), 1 per node, pedicels scabrous (short). **Spikelets** 3.3–3.7 mm long. **First glumes** 1.5–1.7 mm long, one half spikelet or less spikelet length. **Second glumes** 3.1–3.6 mm long (apex not reticulate-veined). **Lower florets** neuter (apex not reticulate-veined). **Lower floret paleas** well-developed. **Upper floret lemmas** 3.1–2.5 mm long, ca 1 mm wide, oval, stramineous. **Chromosome numbers** 2*n*= 36, 54, and 72. **Flowering period** May to August.

Figure 1

Distribution. Texas: a disturbance species of sandy loam soil that is new to Texas (Area 6), Hidalgo County. General: native to tropical Asia, introduced into Florida, reportedly Georgia, Mexico, and the Lesser Antilles.

Voucher Specimens: TEXAS. **Hidalgo Co.**: Weslaco, USDA-ARS Laboratory (near GIS/Remote Sensing Building), 2413 East Highway 83, growing in a yard. 19 Aug 2008, *Everitt s.n.* (TAES) and 1 Jun 2008, *Everitt s.n.* (TAES); Weslaco, Memorial Elementary School, 1700 South Border, E side of school, 19 Aug 2008, *Everitt s.n.* (TAES).

KEY TO THE *UROCHLOA* SPECIES OF TEXAS

1. Panicle branches verticillate at inflorescence base; plants perennial ..... ***U. maxima***
1. Panicle branches single or paired at the inflorescence base; plants annual or perennial.

2. Spikelets single at mid-branch.

3. Panicle branches triquetrous in cross-section ..... ***U. ciliatissima***
3. Panicle branches crescent shaped or flat in cross-section.

4. Upper lemmas awned, awns 0.4–1.3 mm long.

5. Plants annual; leaf blade margins crisp, usually with pappilose based hairs ..... ***U. paniciodes***
5. Plants perennial; leaf blade margins flat, glabrous.. ..... ***U. mosambicensis***

4. Upper lemmas awnless or slightly mucronate; awns less than 0.25 mm long.

6. Spikelets in single row on panicle branches ..... ***U. brizantha***
6. Spikelets in 2 rows on branches.

7. First glumes 5–7-veined; glumes separated by an internode less than 0.3 mm long; spikelets more than 4 mm long ..... ***U. platyphylla***
7. First glumes (7–) 9–11-veined; glumes separated by an internode 0.3–0.5 mm long; spikelets 3.3–3.7 mm long ..... ***U. subquadripara***

2. Spikelets paired at mid branch.

8. Panicle branches triquetrous in cross-section.

9. Spikelets 5–6.2 mm long ..... ***U. texana***
9. Spikelets 2.2–4.1 mm long.

10. Second glumes and lower lemma apices reticulate-veined.. ..... ***U. fusca***
10. Second glumes and lower lemma apices not reticulate-veined.

11. Panicle branches with dense papillose hairs..... ***U. arizonica***
11. Panicle branches with few or no papillose hairs..... ***U. ramosa***

8. Panicle branches flat in cross-section.

12. Spikelets 1.8–2.2 mm long; culms less than 35 cm tall; plants annual ..... ***U. reptans***
12. Spikelets more than 2.5 mm long; culms more than 30 cm tall; plants perennial.

13. Upper lemmas awned, awns 0.5–1.1 mm long; panicle branches 2–8 ..... ***U. mosambicensis***
13. Upper lemmas awnless to murcronate, mucro less than 0.3 mm long; panicle branches usually 10–25 ..... ***U. mutica***

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NOTES ON *LEUCOJUM* AND *NARCISSUS* (AMARYLLIDACEAE) NATURALIZED IN TEXAS

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ABSTRACT

Leucojum aestivum, *Narcissus* ×*intermedius*, and *N. jonquilla*, and *N.* ×*odorus* are documented as apparently naturalized elements of the Texas flora. *Narcissus jonquilla* produces fertile seeds, but the *Leucojum* and the two *Narcissus* hybrids are seed-sterile, remarkable especially in view of the abundance of *N.* ×*intermedius*. A large population of *L. aestivum* is vouchered from along Interstate Highway 20 southeast of Marshall in Harrison Co. *Narcissus* ×*intermedius* is vouchered from large populations along I-20 in Harrison and Gregg cos., *N. jonquilla* from a large I-20 population in Van Zandt Co., and *N.* ×*odorus* from an I-20 population in Gregg Co. Color photos further document the observations and additional collections are cited for each of the taxa. Texas collections of plants outside of cultivation also are cited for *N. papyraceus*, *N. pseudonarcissus*, and *N. tazetta*.

KEY WORDS: *Leucojum aestivum*, *Narcissus* ×*intermedius*, *N. jonquilla*, *Narcissus* ×*odorus*, Amaryllidaceae, naturalized, Texas

The present note documents the uncultivated occurrence of several horticultural herbs of Amaryllidaceae along Texas roadsides, with an attempt to distinguish between records of plants cultivated or persisting from cultivation versus those clearly outside of cultivation. Two of the taxa (*Narcissus jonquilla* L. and *N.* ×*intermedius* Loisel) are abundant, *N.* ×*odorus* L. and *Leucojum aestivum* L. less so.

Photos (Online Appendix 1, Harrison Co.; Online Appendix 2, Gregg Co.) indicate the extent of the *Leucojum* and *Narcissus* populations and show individual plants and features. Vouchers are to be distributed.

LEUCOJUM AESTIVUM L. Summer snowflake

Leucojum aestivum is reported to occur outside of cultivation widely in the eastern USA (Straley & Utech 2002), with the westernmost localities in Texas; a few localities are reported in California and Oregon (Kartesz 2010). The species has been recorded from 27 Louisiana parishes (Thomas & Allen 1993), including Caddo, DeSoto, and Sabine parishes on the Texas border. In Arkansas, it has been recorded from 3 counties (Smith 1988).

In Texas, *Leucojum aestivum* previously has been reported from scattered localities (Diggs et al. 2006; Nesom & Brown 1998). The plants from Dallas Co. were explicitly noted to be escaped, but the Walker Co. collections (SHST) are from cultivated or persisting plants. The present report documents a large, clearly non-cultivated population of more than a hundred plants along Interstate Highway 20 southeast of Marshall.

Harrison Co.: ca. 0.3 mi E of jct I-20 and Texas FM 31, on N side of I-20, ca. 1 mi E of jct I-20 and Hwy 59 on S side of Marshall, gently sloping shoulders of the hwy and swale between the hwy and frontage road, 100+ large clumps scattered irregularly for 100 yards along the hwy frontage, in full flower, mixed with naturalized *Narcissus ×intermedius* in one part of the population, 28 Mar 2010, *Nesom 2010-1* (ASTC, BRIT, TEX).

Additional collections. Texas. **Dallas Co.**: White Rock Lake Park, low, wet, shaded, grassy area, black soil, escaped from cultivation, 18 Mar 1977, *Barnette 64* (SMU). **Panola Co.**: (ASTC, not observed).

Leucojum aestivum is not a "summer" snowflake (i.e., the common name) in Texas, as the plants were in full flower on March 28. Straley and Utech (2002) noted that the flowering period in North America is spring to early summer. At the Harrison County site, mature and maturing fruits examined (4 April 2010) from 40 plants produced no fertile seeds. There is no evidence or indication that the species was originally established at this site through cultivation, and the pattern of dispersion of the plants seems difficult to explain in terms of mechanical movement of the bulbs.

NARCISSUS ×INTERMEDIUS Loisel Star jonquil

Narcissus ×intermedius, according to Straley & Utech (2002), is "known to persist in Louisiana and can be expected elsewhere in the flora area." Serviss (2009) notes that it is "sometimes encountered outside of cultivation in Arkansas, though it is not as common as some of the other *Narcissus* taxa in the state." Observations in the present paper document the occurrence of *N. ×intermedius* outside of cultivation in a number of counties of northeast Texas, where it apparently has been established at least since the late 1940's (see collection citations below). The abundance and patterns of dispersion of these plants initially suggested to me that they are spreading by seeds, but this was contradicted by confirmation of seed-sterility. Reproduction is only by lateral bulbs.

Narcissus ×intermedius is a hybrid between *N. jonquilla* ($2n = 14$) and *N. tazetta* ($2n = 22$) (Meyer 1966). The leaves are flattened, broad (3–10 mm), and concave, the scapes are 3–6-flowered, and the tepals are relatively small and to light or creamy yellow, the corona orange-yellow and distinctly darker than the tepals. Maturing ovaries are ellipsoid-obovoid, 11–14 mm long. Plants and populations of *N. ×intermedius* along Interstate Highway 20 in northeast Texas probably were in full flower in early to mid March. At the Harrison County locality, mature and maturing fruits examined (4 April 2010) from 40 plants produced no fertile seeds; at the Gregg County locality, mature and maturing fruits examined from 20 plants produced no fertile seeds.

Many of the earlier collections of *Narcissus ×intermedius* had been identified as *N. tazetta*, but *N. tazetta* generally flowers later and usually is distinct even in the herbarium, because of its characteristically bright white tepals and flat leaves (see further comments below, under *N. tazetta*).

Harrison Co.: SE of Marshall, ca. 0.3 mi E of jct Hwy I-20 West and Texas FM 31, ca. 1 mi E of jct I-20 and Hwy 59 on the S side of Marshall, on the N side of I-20, gently sloping shoulders of the hwy and swale between the hwy and frontage road, large clumps scattered for 50 yards along the hwy, past full flower, mixed with naturalized *Leucojum aestivum* in one area of the population, tepals yellow, corona slightly darker and yellow to orangish yellow, 28 Mar 2010, *Nesom 2010-2* (BRIT, TEX, ASTC). **Gregg Co.**: S side of Hwy I-20, just W of jct with Texas Hwy 135, ca. 12 mi W of Longview exit (Hwy 259), large population of several hundred clumps on steep sandy roadbank and shoulder of drainage channel, mostly past flower, 4 Apr 2010, *Nesom 2010-4* (ASTC, BRIT, TEX).

Additional collections examined. Texas. **Gregg Co.**: 4 mi NE of Longview on FM 2208, roadside, sandy soil, 31 Mar 1975, *Colquitt 42* (BRIT). **Panola Co.**: 9.5 mi W of Carthage, clayey

ditch bottoms, 24 Feb 1954, *Shinners 18174* (SMU). **Rusk Co.**: 4 3/4 mi SW of Henderson, few plants on sandy roadside, 11 Mar 1949, *Cory 54981* (SMU). **Smith Co.**: 11 2/3 mi NW of Wright City, few plants on sandy roadside, 11 Mar 1949, *Cory 54881* (SMU); 2 mi NW of Mt. Sylvan, sandy clay road fill in pastured stream bottoms, 26 Feb 1954, *Shinners 18210* (SMU). **Walker Co.**: W edge of Huntsville, 1 plant in grassy roadside ditch, an escape from cultivation from yard on low hill, 6 Mar 1948, *Cory 53925* (SMU).

NARCISSUS ×ODORUS L. Campernelle jonquil

Narcissus ×odorus is "one of the most frequently cultivated *Narcissus* in Arkansas and one of the most commonly encountered outside of cultivation" (Serviss 2009). It is documented by Smith (1988) from three Arkansas counties and by Thomas and Allen (1993) from 11 Louisiana parishes. It apparently has not previously been documented from outside of cultivation in Texas.

Narcissus ×odorus is a hybrid between *N. jonquilla* (2*n* = 14) and *N. pseudonarcissus* (2*n* = 14) (Meyer 1966). Mature and maturing fruits examined (4 April 2010) from 10 plants at the Gregg County locality produced no fertile seeds. The plants are characterized by flowers 1–2(–3) per scape with yellow, uniformly colored tepals and corona, relatively narrow tepals, and a distinctly lobed corona. The leaves are flattened and deeply concave, similar to those of *N. ×intermedius* but narrower in width (3–6 mm).

At the Gregg County locality, the plants of *Narcissus ×odorus* were in dense clumps at and near the top of the steep roadbank. They occur at the edge of a much larger population of *N. ×intermedius* (*Nesom 2010-4*), the two barely intermixed only where in contact. According to the owner (who stopped to question me) of the property adjacent to the road, there has never been a home site at the locality, now a pasture and cut-over woods.

Gregg Co.: S side of Hwy I-20, just W of jct with Texas Hwy 135, ca. 12 mi W of Longview exit (Hwy 259), population of ca. 30 large clumps near top of steep sandy roadbank, at the edge of a large population of *N. ×intermedius* (*Nesom 2010-4*), tepals and corona uniformly yellow, mostly past flower, 4 Apr 2010, *Nesom 2010-5* (ASTC, BRIT, TEX).

NARCISSUS JONQUILLA L. Jonquil

Narcissus jonquilla is known to occur outside of cultivation widely in the eastern USA (Straley & Utech 2002; Kartesz 2010). The species has been recorded from 21 Louisiana parishes (Thomas & Allen 1993), including Vernon, DeSoto, and Sabine on the Texas border. In Arkansas, it has been recorded from 12 counties (Smith 1988).

In Texas, *Narcissus jonquilla* has been reported from Grayson and Hunt cos. (Diggs et al. 2006), Madison Co. (Neill & Wilson 2001), and Victoria Co. (TEX voucher). The collection from Madison Co. was from a cultivated plant (TAMU voucher); label information on the Victoria Co. collection (TEX voucher) does not indicate whether the plant was cultivated or naturalized; no voucher was located for the Grayson Co. collection cited by Diggs et al. (2006); the Hunt Co. collection is confirmed as naturalized and cited below.

The present report documents *Narcissus jonquilla* as unambiguously naturalized along the side of Interstate Highway 20 northwest of Canton (Van Zandt Co.). The plants appear to be typical of the species, with terete stems, 1–2(–3) flowers per scape, and small, uniformly golden yellow corollas. Mature fruits are broadly ellipsoid to short-cylindric, 7–10 mm long, and produce 2–3 seeds per carpel (10 plants sampled, 28 March). Among the Texas taxa observed here, *N. jonquilla* (at least this particular population) apparently is the only one that produces fertile seeds.

Van Zandt Co.: NW of Canton, between Hwy I-20 West and frontage road, W side of Co. Road 3439/3442, ca. 0.6 mi E of Turner-Hayden Road, broad open field with low areas and drainages, thousands of plants and clumps over ca. 1200 square yards, past full flower, 28 Mar 2010, *Nesom 2010-3* (ASTC, BRIT, TEX).

Additional collections examined. Texas. **Erath Co.**: 1 mi NE of Stephenville, wet land, 1 Apr ca. 1961, *Caddell 509* (SMU). **Hunt Co.**: 4.5 mi E of Greenville, sandy clay road shoulder, 6 Mar 1949, *Shinners 10631* (SMU). **Newton Co.**: just E of Texas Hwy 87 in Burkeville, graveyard, 19 Feb 2007, *Allen et al. 19612* (BRIT). **San Augustine Co.**: 2 mi W of San Augustine, foot of road fill near small stream, sandy clay, 23 Feb 1954, *Shinners 18149* (SMU). **Shelby Co.**: 11.5 mi NE of Center, sandy clay roadside, 23 Feb 1954, *Shinners 18130* (SMU).

Excellent photos of naturalized *Narcissus jonquilla* from **Nacogdoches Co.** are on the Pineywoods Plants Digital Gallery (Van Kley 2010)—photographed in the spring of 2003 from plants along Hwy 21 East near the Nacogdoches city limit (fide James Van Kley pers. comm.).

Other species of *Narcissus* outside of cultivation in Texas

Many species and forms of *Narcissus* are cultivated in Texas. An excellent online overview of the genus, with photographs and commentary, that covers all or most of the Texas species and hybrids is given by Serviss (2009) for Arkansas. The entry for *Narcissus* in Wikipedia (2010) also gives a useful overview of the genus. A number of useful references are available, e.g., Lee (1966), Blanchard (1990), Jefferson-Brown (1991), Heath & Heath (2001), Hanks (2002a, 2002b).

In addition to the three taxa of *Narcissus* discussed and documented above, three others are known to occur outside of cultivation in Texas.

NARCISSUS PSEUDONARCISSUS L. Daffodil, trumpet narcissus

Narcissus pseudonarcissus was reported for Hunt and Grayson counties by Diggs et al. (2006); vouchers for these records have not been located. Scattered plants of *Narcissus pseudonarcissus* are encountered in Fort Worth (Tarrant Co.) outside of cultivation and apparently in situations where it seems unlikely that they were planted. All such that I have seen have been seed-sterile.

Collections examined. Texas. **Smith Co.**: western Tyler, N of Pine Burr Road, one plant seen in open pine woods, 17 Feb 1950, *Cory 56979* (SMU). **Rockwall Co.**: cemetary near Hwy 66, open grassy area, 27 Feb 1983, *Pendleton 14* (BRIT). **Upshur Co.**: N side of Hwy 154, 6.5 mi W of Gilmer, clumps along the roadside, 23 Feb 2001, *Chevalier 19* (TAMU, fide M. Reed). **Wood Co.**: jct of Hwy 154 and Hwy 182, 20 Feb 1976, *Sampson 6* (SMU).

NARCISSUS TAZETTA L. Polyanthus narcissus, cream narcissus

Narcissus tazetta has been reported and recorded from various localities in Texas, but the occurrences apparently are isolated and it does not appear to be abundant anywhere. Collections of *N. tazetta* (TEX vouchers) mapped by Kartesz (2010) from El Paso and Hays counties are explicitly from cultivated plants; there is no TEX-LL voucher for the mapped collection from Victoria County.

Narcissus tazetta varies greatly in flower size and color, number of flowers per scape, and leaf width. Flowers "range from almost white, with the corona pale cream in color, to flowers with a yellow perianth and orange corona" (Serviss 2009). All Texas plants observed here of *N. tazetta* apparently have white tepals, but given the potential range of overlap in corolla color between *N. tazetta* and *N.* ×*intermedius*, identification of *N. tazetta* should be confirmed by the presence of flat

leaves (vs. deeply concave in *N.* ×*intermedius*). *Narcissus tazetta* also apparently is distinct in its April flowering (vs. mostly February and March in *N.* ×*intermedius*).

As in other taxa of *Narcissus*, variability in *N. tazetta* at least partly reflects strong and long-continued artificial selection. The native range of *N. tazetta*, however, stretches from the Iberian peninsula and north Africa across Asia through the Himalayan region to Japan, and Meyer (1966) recognized 15 subspecies within the species.

Collections examined. Texas. **Angelina Co.**: Lufkin, escaped ornamental in large clump, 7 Apr 1960, *Gentry and Barclay 18498* (LL). Brazos Co.: Bryan, S side of Hwy 21, ca. 2 mi E jct. Hwy 47, 17 Feb 2002, *Peel 7* (TAMU, fide M. Reed). **Fannin Co.**: Meadow about 1 mi N of Monkstown, Rte 100, escape!, flowers white with yellow crown, 25 Apr 1969, *Correll 37077* (LL). **Galveston Co.**: Bacliff, 500 block of Baker St. at Baker St. and Covert St., escaped from cultivation, 31 Jan 1975, *Waller and Bauml 3341* (TEX). **Smith Co.**: 13.2 mi E of Tyler on Hwy 31, hwy right-of-way, not near house, 23 Apr 1953, *Shinners 14403* (SMU). **Van Zandt Co.**: 10 mi SE of Canton on US 64, road margin, clay, 26 Apr 1975, *Gregg 37* (SMU. **San Augustine Co.**: 2 mi N of San Augustine, foot of road fill near small stream, lvs flat, 23 Feb 1954, *Shinners 18150* (SMU).

NARCISSUS PAPYRACEUS Ker Gawl. Paper-white narcissus, paperwhite

Narcissus papyraceus was reported for Brazos County by Diggs et al. (2006), but no voucher has been located.

Collection examined. Texas. **Newton Co.**: Jesse Lee Park, off Texas Hwy 363, creek bank, 19 Feb 2007, *Allen et al. 19644* (BRIT).

Straley & Utech (2002) noted that "Although *Narcissus papyraceus* and *N. tazetta* are distinct and easily distinguished as fresh specimens, they are very difficult to separate in herbarium material." Serviss (2009), however, observes that "The only real consistent distinguishing characteristic of *N. papyraceus* from *N. tazetta* is its completely white corona (the coronas of *N. tazetta* are cream, yellow, or orange in color)." Meyer (1966) treated *N. papyraceus* as *N. tazetta* subsp. *papyraceus* (Ker Gawl.) Baker. In the Italian flora, Pignatti (1982) included *N. papyraceus* as a probable synonym of a more broadly defined *N. tazetta* subsp. *tazetta*.

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Photos (Online Appendix 1, Harrison Co.)

1. Mixed populations of *Leucojum aestivale* and *Narcissus ×intermedius*. Harrison Co., se of Marshall (*Nesom 2010-1*, *Nesom 2010-2*).

2, 3, & 4. Plants of *Leucojum aestivale*. Harrison Co., se of Marshall (*Nesom 2010-1*).

5 & 6. Plants of *Narcissus ×intermedius*. Harrison Co., se of Marshall (*Nesom 2010-2*).

7 & 8. Population of *Narcissus jonquilla*. Van Zandt Co., nw of Canton (*Nesom 2010-3*).

9 & 10. Plants of *Narcissus jonquilla*. Van Zandt Co., nw of Canton.

Photos (Online Appendix 2, Gregg Co.)

1 & 2. Mixed populations of *Narcissus ×intermedius* (*Nesom 2010-4*) and *N. ×odorus* (*Nesom 2010-5*). Gregg Co., w of Longview. Most plants are *N. ×intermedius*.

3, 4, & 5. Plants, flowers, and fruits of *Narcissus ×intermedius*. Gregg Co., w of Longview.

6. Flower of *Narcissus ×odorus*. Gregg Co., w of Longview.

Turner, B.L. 2010. Rescension of the Mexican *Amauriopsis* (Asteraceae: Bahieae). Phytoneuron 2010-10: 1-7. Mailed 13 May 2010.

RECENSION OF THE MEXICAN *AMAURIOPSIS* (ASTERACEAE: BAHIEAE)

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ABSTRACT

The recently resurrected genus *Amauriopsis* (*Bahia* series *Alternifoliae* of Ellison) is treated as having six species, five of these native to Mexico. One of these, *A. biternata*, so far as known, is confined to the USA. A new taxon, **Amauriopsis janakosana** B.L. Turner, sp. nov., is described from northeastern Chihuahua. New combinations are these: **A. autumnalis** (Ellison) B.L. Turner, comb. nov., **A. biternata** (A. Gray) B.L. Turner, comb. nov., **A. glandulosa** (Greenm.) B.L. Turner, comb. nov., and **A. pedata** (A. Gray) B.L. Turner, comb. nov. A key to the species is provided, along with maps showing the Mexican distributions, all of this in the format of my upcoming treatment of the tribe Bahieae for the Comps of Mexico (cf. Turner 1997, Phytologia Memoirs 11).

AMAURIOPSIS Rydb., N. Amer. Fl. 34: 37. 1914.

Annual or biennial herbs with alternate leaves. Heads mostly radiate in terminal paniculate cymes. Involucres hemispheric to campanulate, the bracts subequal in two series. Receptacles flat to convex, epaleate. Ray florets pistillate, fertile, yellow or yellow-orange. Disk florets numerous, bisexual, mostly yellowish, the corollas regular to somewhat zygomorphic. Anther appendages ovate, lacking glandular trichomes. Style branches deltoid apically, the stigmatic lines narrow. Achenes obpyramidal, variously pubescent; pappus of ca 8–16 scales, the midrib usually included, rarely absent. Base chromosome number, x = 12.

Type species, *Amauriopsis dissecta* (A. Gray) Rydb.

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A mostly western North American genus with 6 species, 5 of these native to Mexico, the sixth confined to the USA. Ellison (1964) included all of these within his concept of *Bahia* series *Alternifoliae*. DNA data, however, strongly indicate that these are better treated as a separate genus (Panero 2007), and such is followed here. So treated, *Bahia* sensu stricto comprises species with strictly opposite leaves (series *Oppositifoliae*). As will be noted in the synonymy below, at least two species (*A. biternata* and *A. dissecta*) have been included in the extra-tribal genus Villanova, but DNA data (Baldwin et al. 2002; Panero 2007) negate such a positioning.

KEY TO THE SPECIES

1. Plants perennial from woody rootstocks; leaves tripartite ..... **Amauriopsis janakosana**
1. Plants annual from slender taproots; leaves multipartite ..... (2)

2. Ray florets white or creamy-white ..... **Amauriopsis glandulosa**
2. Ray florets yellow ..... (3)

3. Peduncles puberulent, but not glandular-pubescent; e Coa, Nue ..... **Amauriopsis autumnalis**
3. Peduncles densely glandular-pubescent ..... (4)

4. Inner achenes with pappus scales having an excurrent awn; leaf segments mostly 1–3 mm wide ..... **Amauriopsis biternata**
4. Inner achenes with pappus absent or if scales present not aristate; leaf segments mostly 3–5 mm wide ..... (5)

5. Pappus absent or rarely present (when present the scales lanceolate); Bajn, Son, Chi, w Coa ..... **Amauriopsis dissecta**
5. Pappus of obovate to oblanceolate or spatulate scales; Chi, Coa, Nue, Dur, and adjacent USA ..... **Amauriopsis pedata**

AMAURIOPSIS AUTUMNALIS (Ellison) B.L. Turner, **comb. nov.** Map 1. Based upon *Bahia autumnalis* Ellison, Rhodora 66: 199. 1964.

Coa and Nue, rocky limestone soils, mostly thorny scrublands, 500–1000 m; Oct–Nov.

Robust annual or biennial, mostly eglandular, herbs to 1.5 m high; stems leafy throughout; leaves mostly alternate, 4–12 cm long, ternately divided into mostly linear-oblanceolate segments; heads radiate, numerous on ultimate peduncles 0.5–4.5 cm long; involucre hemispheric, 2–3 seriate, the bracts subequal; receptacle convex, epaleate; ray florets 13–21, pistillate, fertile, the ligules 13–21, yellow, 4–5 mm long; disk florets numerous, yellow; achenes pubescent below, and along the angles, the faces glabrous; pappus of 11–12 lacerate scales 1.0–1.3 mm long; chromosome number, $n = 12$ pairs.

A very distinctive, fall-flowering, species, not easily confused with another. Noteworthy is a specimen (*Hinton 23993*, Aramberri, Nue) from gypseous soils having much smaller heads with fewer florets; I take this to be a small-headed form of the present. Occasional plants from the vicinity of Rayones, Nue (e.g., *Hinton et al. 28563*) are densely glandular-pubescent throughout, suggesting genetic influence of *Amauriopsis pedata*.

AMAURIOPSIS BITERNATA (A. Gray) B.L. Turner, **comb. nov.** Map 2. Based upon *Bahia biternata* A. Gray, Pl. Wright. 2: 95. 1853.
Eriophyllum biternatum (A. Gray) Kuntze
Schkuhria biternata (A. Gray) A. Gray
Villanova biternata (A. Gray) Woot. & Standl.

Not collected in Mexico as yet, but to be anticipated along the northern borders of Son and Chi, since it is known to occur in the central and southern counties of Arizona and New Mexico in the USA.

This taxon is closely related to *Amauriopsis pedata*, the latter not having aristate pappus scales. The possibility that *A. biternata* is but a awned-pappus populational expression of the latter could be investigated in the field.

AMAURIOPSIS DISSECTA (A. Gray) Rydb., N. Amer. Fl. 34: 37. 1914. Map 3. *Amauria dissecta* A. Gray, Mem. Amer. Acad. Arts, n.s., 4: 104. 1849.
Bahia chrysanthemoides (A. Gray) A. Gray
Bahia dissecta (A. Gray) Britton
Bahia dissecta var. *anisopappa* Blake
Eriophyllum chrysanthemoides (A. Gray) Kuntze
Villanova chrysanthemoides A. Gray
Villanova dissecta (A. Gray) Rydb.

Bajn, e Son, n Chi, n Coa, and southwestern USA (Arizona, California, Colorado, Nevada, New Mexico, Texas, Utah, Wyoming), juniper-pine woodlands, 1600–2200 m; Jul–Oct.

Annual herbs to 1.5 m high; much resembling *A. pedata* but the foliage scarcely glandular-pubescent, if at all, the ultimate divisions finer; technically, *A. dissecta* is distinguished from *A. pedata* by its nearly glabrous, epappose achenes. Blake, however, recognized pappose forms from Bajn as the var. *anisopappa*. In all other characters, however, plants of the latter are similar to *A. dissecta*; chromosome number, $n = 18$ pairs.

AMAURIOPSIS GLANDULOSA (Greenm.) B.L. Turner, **comb. nov.** Map 4. Based upon *Bahia glandulosa* Greenm., Proc. Amer. Acad. Arts 39: 116. 1904.
Hymenopappus glandulopubescens Waterfall

Dur, Zac, Agu, and n Jal, grasslands and pine-oak woodlands, 1900–2300 m; Aug–Nov.

Annual or biennial herbs to 1.5 m high; leaves mostly alternate, pedately dissected, the foliage usually glandular-pubescent throughout; otherwise resembling *Amauriopsis pedata* but readily distinguished by its white rays; chromosome number, $n = 12$ pairs.

Most of the distributional records from Zac are from Balleza and Villasenor (2002).

AMAURIOPSIS JANAKOSANA B.L. Turner, **sp. nov.** Fig. 1, Map 4.
Amauriopsi pedatae (A. Gray) B.L. Turner similis sed differt duratione perenni (vs annui) radicibus ligneis, foliis minute glandulosi-pubescentibus (vs manifeste pilosis), et acheniis villosis (vs hispidulis).

Perennial herbs to 1 m high. Stems several from the apex of a woody crown or root; mid-stems minutely glandular-pubescent to nearly glabrate, with a smattering of minute eglandular hairs. Leaves tripartite, their margins irregularly lobed, if at all, pubescent like the stems; petioles 2.0–3.5 cm long. Capitulescence a terminal paniculate cyme ca 15 cm high, the ultimate peduncles 2–5 cm long. Heads ca 2 cm across the extended rays; involucral bracts 2–3 seriate, weakly gradate, sparsely pubescent like the stems, the inner bracts lanceolate, apiculate, 7–8 mm long. Receptacle convex, naked, ca 3 mm wide. Ray florets ca 8(?), pistillate, fertile; ligules ca 5 mm long, yellow. Disk florets numerous, yellow. Achenes 4-sided, nervate, ca 4 mm long, villous throughout with upwardly appressed hairs; pappus of ca 16, flabellate, nervate scales ca 2 mm long.

TYPE: MEXICO. Chihuahua. Mpio. Ojinaga, 33.5 km by winding road SE of Ejido Paso de San Antonio toward Rancho El Carrizal Grande (Coah.), NE flank of Sa. de Hechiceros, 28° 51' N,

103° 34' W, 950–1150 m, matorral desertico con esp. laterales, steep slopes [of] extrusive igneous rock, gravelly and grussy, very crumbly, 2 Oct 1972, *F. Chiang, T. Wendt*, and *M.C. Johnston 9665* (holotype: LL).

Named for Jana Kos (age 55; born in Czechoslovakia, naturalized in the USA), a delightful colleague of mine at the University of Texas, where we first met. She was teaching Czech at the time but subsequently became interested in botany as a result of our field sorties along the Mexican border regions. Jana is like the above novelty in many ways: she is a poorly known individual whom I discovered by pure chance (much as the Type of *Amauriopsis janakosana*, a unusual specimen hidden among a stack of *A. pedata* collections!). More important, her intelligence, singular ideals, and loyalty are remarkable, and I find her fully deserving of the eponymy rendered.

AMAURIOPSIS PEDATA (A. Gray) B.L. Turner, **comb. nov.** Map 5. Based upon *Bahia pedata* A. Gray, Pl. Wright. 1: 123. 1852.
Eriophyllum pedatum (A. Gray) Kuntze
Schkuhria pedata (A. Gray) A. Gray

Chi, Coa, Nue, Dur, and adjacent USA (New Mexico and western Texas), pine-oak woods, 1000–1800 m; Aug–Dec.

Annual, biennial or short-lived perennial herbs to 1.2 m high; leaves mostly alternate, pedately dissected, the ultimate divisions rather broad and ovate in outline, sparsely to densely pubescent; heads radiate, few to numerous, the ultimate peduncles densely glandular-pubescent; involucres 2-seriate, the bracts 4–6 mm long, subequal; ray florets 11–15, fertile, the ligules yellow, 5–8 mm long; disk florets 70–110, the corollas yellow; achenes 2.5–4.5 mm long, 4–10 ribbed, hispidulous, the pappus of 10–16, nervate, obovate to oblanceolate or spatulate scales; chromosome number, $n = 12$ pairs.

Occasional specimens from the vicinity of Monterrey, Nue, superficially resemble *Amauriopsis pedata*, as noted under *A. autumnalis*.

ACKNOWLEDGEMENTS

As always, I am grateful to my colleague Guy Nesom for the Latin diagnosis and for reviewing the paper.

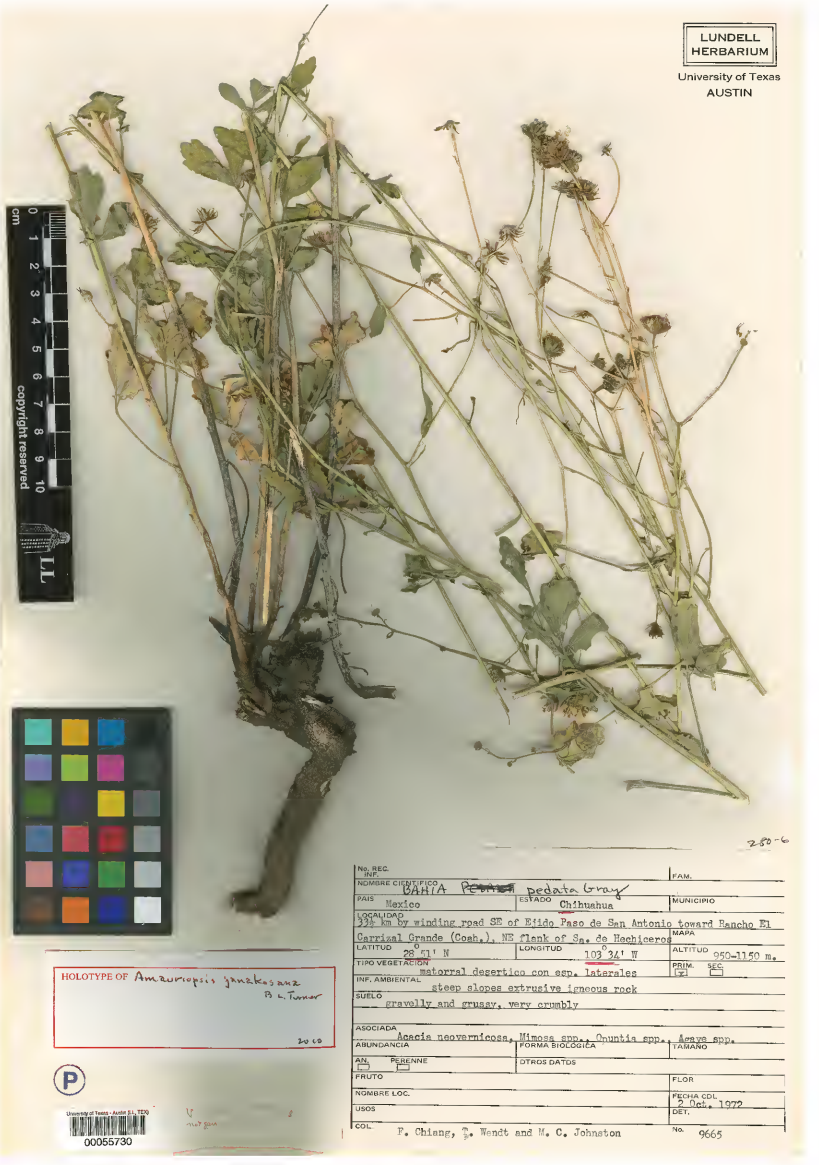
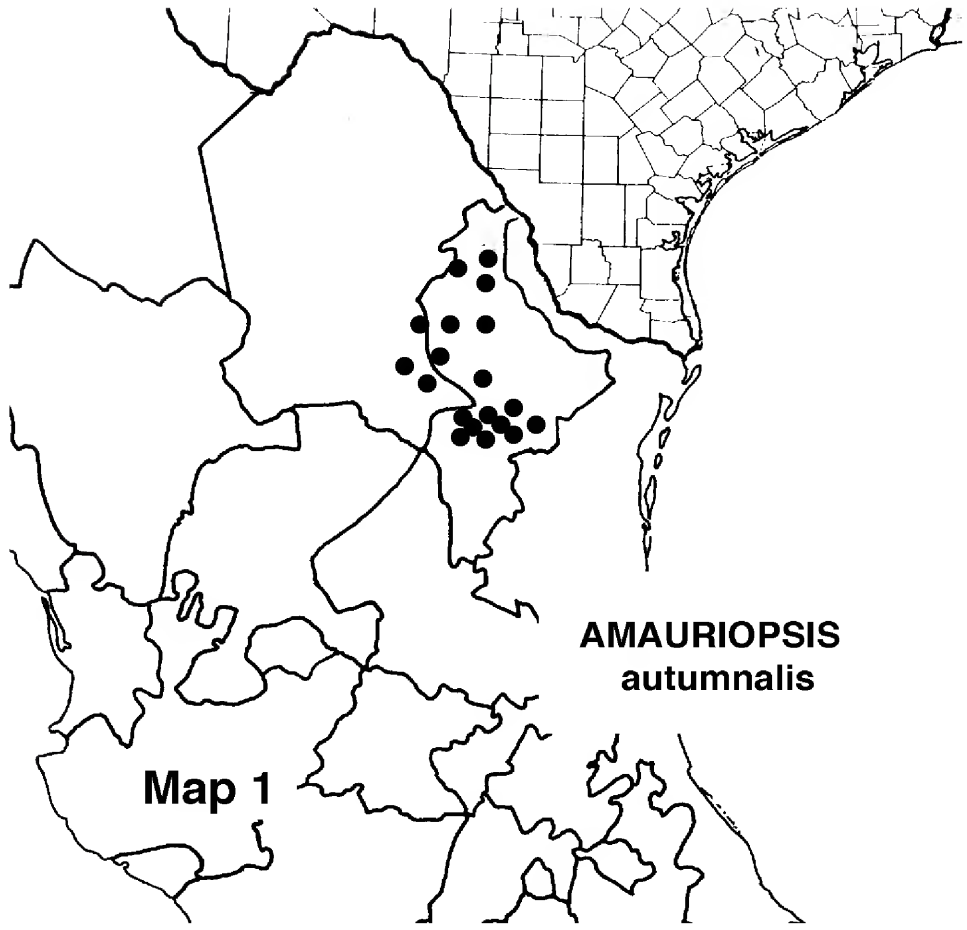
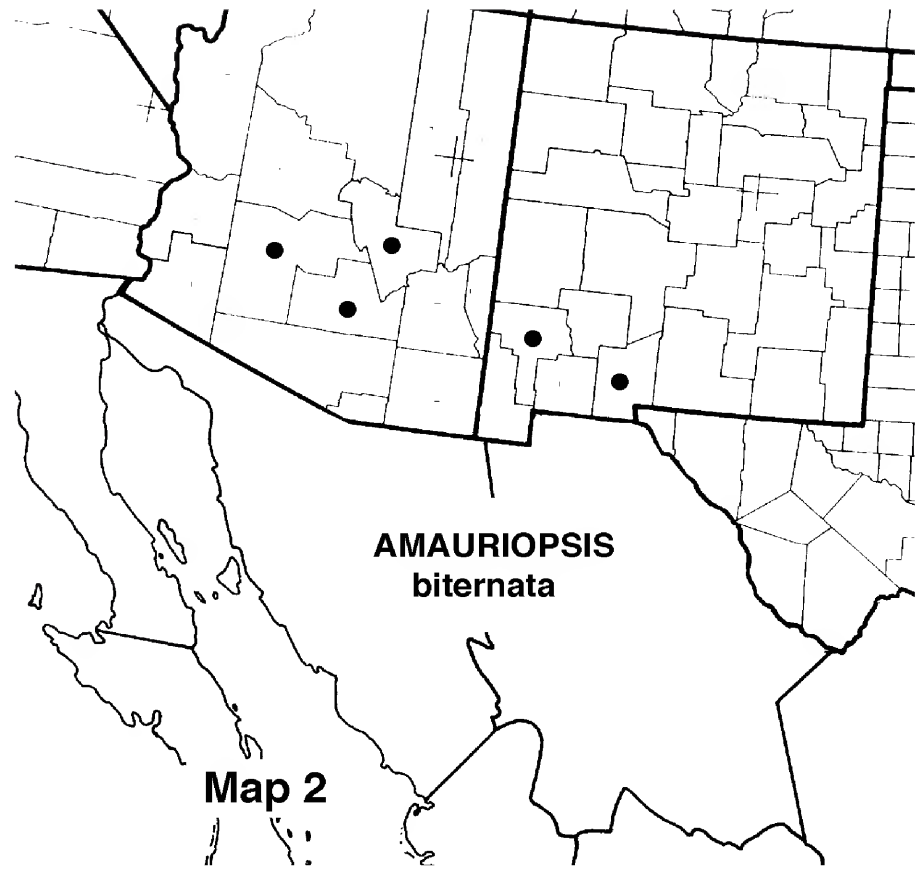


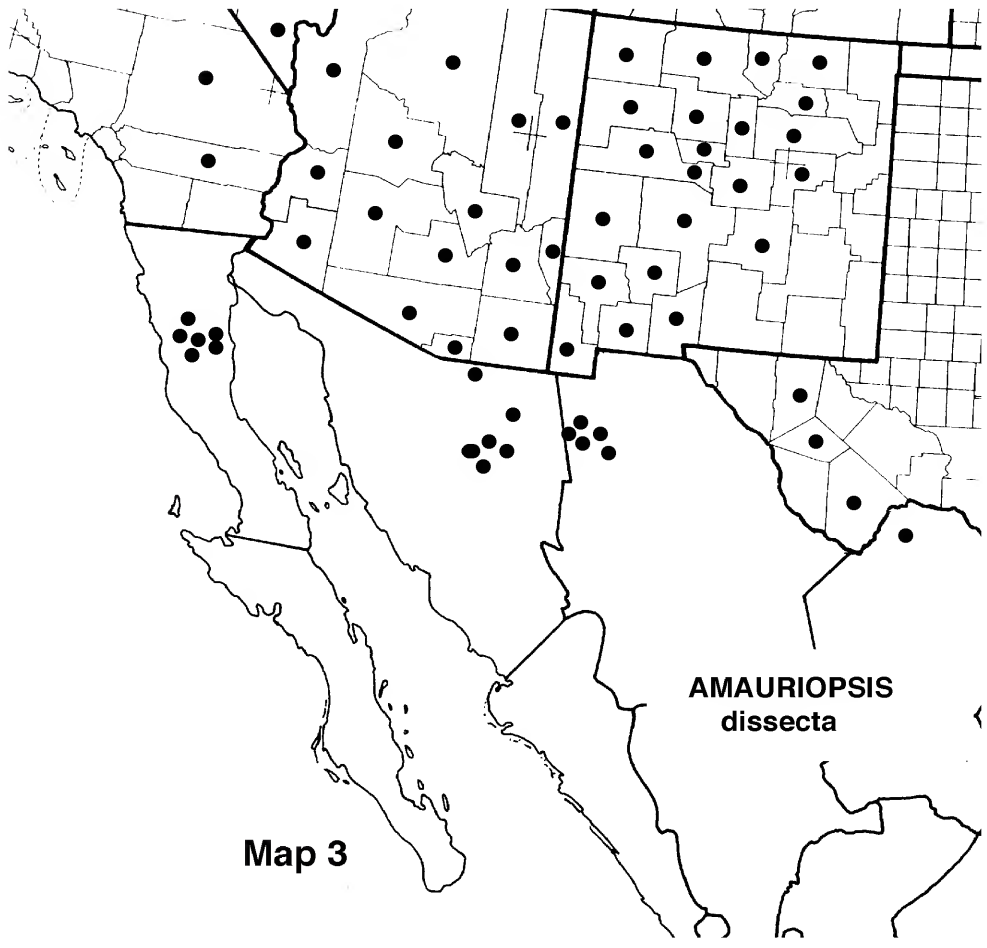
Figure 1. Holotype of *Amauriopsis janakosana* B.L. Turner.



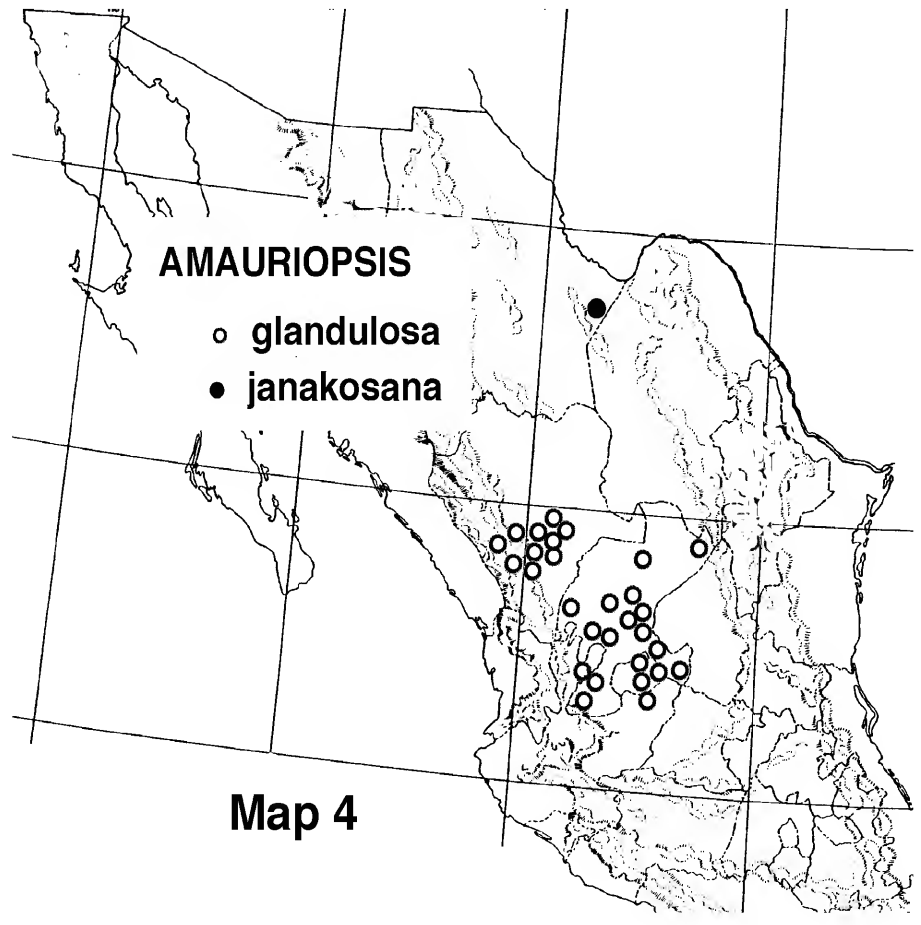
Map 1



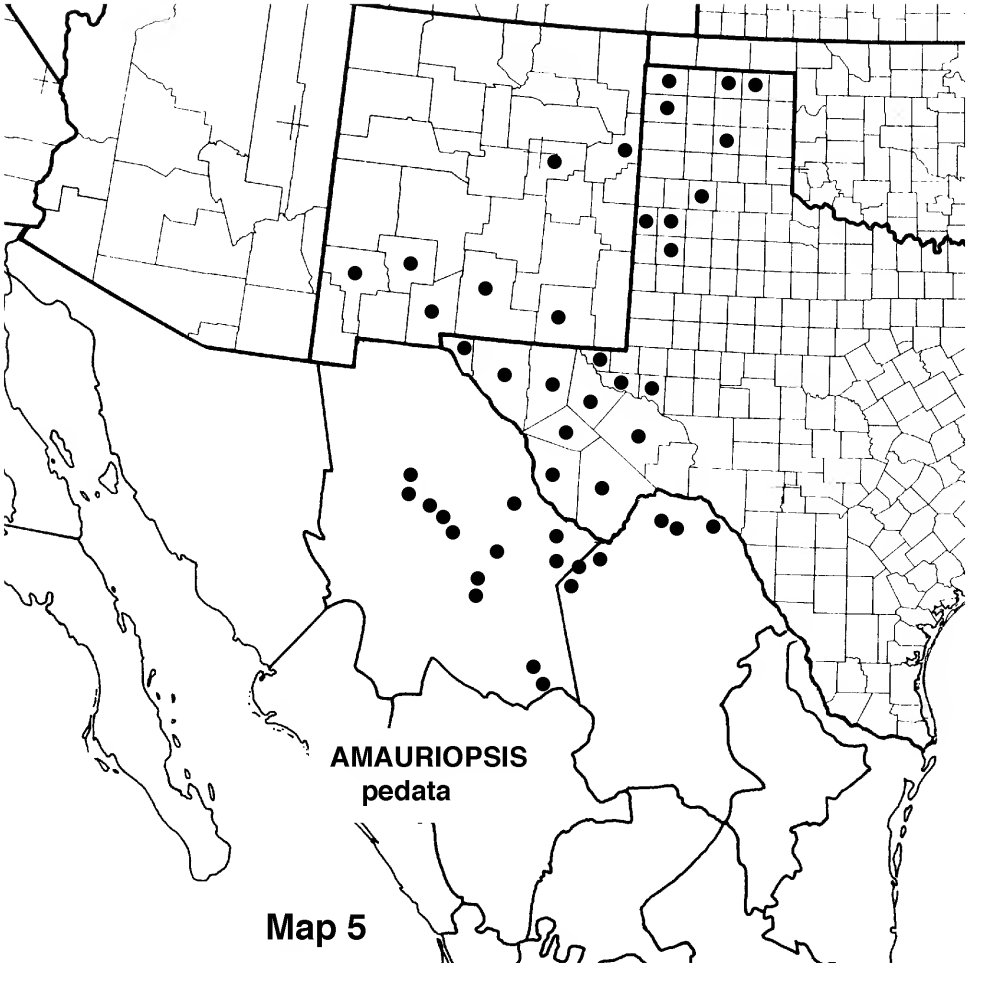
Map 2



Map 3



Map 4



Map 5

Nesom, G.L. 2010. Infrageneric classification of *Verbena* (Verbenaceae). Phytoneuron 2010-11: 1–15. Mailed 13 May 2010.

INFRAGENERIC CLASSIFICATION OF *VERBENA* (VERBENACEAE)

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ABSTRACT

The genus *Verbena* sensu stricto in the present account includes 70 species (6 currently in the process of description). The genus is divided into three sections: 1. Sect. *VERBENA*, type *V. officinalis* (including 10 series: ser. *Verbena*; **ser. Haleae** Nesom, ser. nov., type *V. halei*; **ser. Plicatae** Nesom, ser. nov., type *V. plicata*; **ser. Simplices** Nesom, ser. nov., type *V. simplex*; **ser. Connaticarpae** Nesom, ser. nov., type: *V. carnea*; ser. *Leptostachyae* Schauer, lectotype (designated here) *V. urticifolia*; **ser. Candelabrae** Nesom, ser. nov., type *V. stricta*; **ser. Bracteatae** Nesom, ser. nov., type *V. bracteata*; **ser. Californicae** Nesom, ser. nov., type *V. californica*; and **ser. Tricesimae** Nesom, ser. nov., type *V. canescens*); 2. **Sect. *AMPHEPEIROS*** Nesom, sect. nov., type *V. glabrata* (including 2 series: **ser. Austrobrasilienses** Nesom, ser. nov., type *V. hirta*; and **ser. Pacificae** Nesom, ser. nov., type *V. glabrata*); and 3. Sect. *VERBENACA* Walpers, lectotype (designated here) *V. bonariensis* (including 2 series: ser. *Pachystachyae* Schauer, type *V. bonariensis*; and **ser. Litorales** Nesom, ser. nov., type *V. litoralis*). The three sections are delimited primarily on the basis of inflorescence structure.

KEY WORDS: *Verbena*, Verbenaceae, infrageneric classification, sections, series

The only inclusive, critical study of North American *Verbena* L. sensu stricto has been provided by Perry (1933). Moldenke's contributions "toward a monograph of the genus" (1961–1964) covered all of the taxa, but they were oriented toward nomenclature and literature and did not provide evaluation of patterns of variation; nor did Moldenke provide a key to species, except in a few regional floristic accounts. Since a recent overview by Sanders (2001), most of the native South American taxa have been examined in revisionary detail (O'Leary et al. 2007; Nesom 2010a); certain groups of the North American species have been studied in detail (Nesom 2010b, 2010c, 2010f, 2010g). O'Leary et al. (2010) present a revision of the species they consider to represent lineages apart from the primary ones of South America—included are species native to the USA, Mexico, South America, and Europe. The Flora of North America treatment (Nesom submitted) includes the native and naturalized species of North America north of Mexico.

Verbena in the account here includes 70 species. Other recent estimates (e.g. Sanders 2001, "40 to 50" species; O'Leary et al. 2007 and 2010, 45 and 44 species, respectively) have been generally similar, but Atkins (2004) estimated between 200 and 250 species, even though she treated both *Glandularia* Gmelin and *Junellia* Moldenke as segregates of *Verbena*. The species of *Verbena* series *Pachystachyae* Schauer (sensu O'Leary et al. 2007) are native to South America; five of these are naturalized elsewhere in the world. Most of the remaining species are North American and Central American, except for two European species, *V. supina* L. and *V. officinalis* L., which apparently are most closely related to North American natives. Australian segregates of *V. officinalis* have been recognized (Michael 1997; Munir 2002; comments in Nesom 2010b). Two species of northwestern South America also are hypothesized here to be closely related to *V. officinalis*.

Tribe Verbeneae Schauer includes *Verbena*, *Glandularia* (ca. 100 species), *Junellia* (ca. 30 species, including the monotypic *Urbania* Phil.), and *Mulguraea* O'Leary & Peralta (19 species) (O'Leary et al. 2009). *Hierobotana* Briq. (1 species, *H. inflata* (Kunth) Briq.) also has been included among these (e.g., Atkins 2004), but its status apparently remains unresolved—its disposition was not mentioned in O'Leary et al. (2009), even under the subheading "Relationship among genera of Tribe Verbeneae: *Verbena*, *Glandularia*, *Junellia* and *Mulguraea*." This group is characterized by fruits that separate into four 1-seeded mericarps, mostly parallel anther thecae often with dilated and glandular connective, and 2-lobed styles with the anterior lobe stigmatic. *Glandularia* has its center of diversity in South America and *Junellia* and *Mulguraea* occur only in that area. The largest number of *Verbena* species occurs in Mexico and the USA. Botta (1989) included *Tamonea* Aublet (6 species) as part of this group, but Atkins (2004) and O'Leary et al. (2008) have placed it in tribe Casselieae. *Verbena carnea* Medik. has been treated as the monotypic genus *Stylodon* Raf., based primarily on its mericarps that are connate at maturity, but in other features, *V. carnea* is similar to North American species of *Verbena* and the connation of mericarps is interpreted here as a derived feature within the genus. Recent DNA studies of the Verbeneae (Marx et al. in prep., Dick Olmstead pers. comm.) indicate that both *Hierobotana* and *Stylodon* evolved from within the evolutionary matrix of *Verbena* sensu stricto.

Phylogenetic reconstructions by Yuan and Olmstead (2008a, 2008b) indicate that *Glandularia* and *Verbena* are monophyletic sister groups, together having a sister relationship to *Junellia* sensu stricto (O'Leary et al. 2009). Phylogenetically basal to tribe Verbeneae is the newly described *Mulguraea*, a genus, like *Junellia*, primarily of the arid Andean region.

The close relationship between *Verbena* and *Glandularia* is emphasized by the discovery (Yuan & Olmstead 2008a) that two independent intergeneric chloroplast transfers have occurred, both from *Verbena* to *Glandularia*. "One is from a diploid North American *Verbena* species [*V. hastata* or *V. orcuttiana*, as sampled] to a polyploid North American *Glandularia* species [*G. bipinnatifida* (Nutt.) Nutt., as sampled]. The other is more ancient, from the South American *Verbena* group [sect. *Verbenaca*] to the common ancestor of a major *Glandularia* lineage [including *G. canadensis* (L.) Nutt.], which has radiated subsequently in both South and North America."

Most infrageneric classifications of *Verbena* have included *Glandularia* and/or *Junellia*, and *Verbena* species have mostly been grouped in series or unranked groups (Walpers 1845; Schauer 1847; Briquet 1895; Small 1933; Troncoso 1974). Moldenke (1961) simply repeated the system of Walpers. O'Leary et al. (2007) studied only South American species, placing them all in 2 subseries within series *Pachystachyae* Schauer. O'Leary et al. (2010) divided the remaining species (ser. *Verbena*) among three unranked groups: *Verbena*, *Hastatae*, and *Bracteosae*. Sanders (2001) arranged the species of the southeastern USA into five informal groups. Among the few (14) species of *Verbena* sensu stricto sampled in a molecular phylogenetic studies by Yuan and Olmstead (2008a, 2008b) and Yuan et al. (2010), essentially two main species groups are evident, corresponding essentially to South American and North American species. Cladistic positions of the few-sampled North American species are inconsistent among data sets and types of analyses.

In their classification of *Verbena*, O'Leary et al. (2007, 2010) have divided the species between two groups, emphasizing two basic types of stem anatomy: Type A—cortical parenchyma continuous and discrete along the circumference, not interrupted at the stem angles by columns of sclerenchyma (their Fig. 2C); and Type B—cortical parenchyma interrupted at the stem angles by thick columns of sclerenchyma joined to the angular tissue (their Fig. 2D). Type B anatomy is characterized externally by a sharply 4-angled appearance and more prominent development of the angular nerves. All of the species except *V. rigida* of their "subser. *Pachystachyae*" (= ser. *Pachystachyae* in the present arrangement) are characterized by Type B anatomy. All of these are South American. O'Leary et al.

placed South American species with Type A anatomy (except for *V. rigida*) within subseries *Pseudoracemosae*, a morphologically heterogeneous group dispersed here among ser. *Austrobrasilienses* and ser. *Verbena*. Native North American species have Type A anatomy, fide O'Leary et al. (2010).

In preparation of a taxonomic treatment of *Verbena* for the Flora of North America North of Mexico, I have attempted to delimit natural groups within the genus.

The three sections are recognized within *Verbena*, primarily based on inflorescence structure.

1. Inflorescence paniculate, with spikes solitary or irregularly arranged, not in definite 3's; spikes not subtended by prominent foliaceous bracts, all spikes pedunculate; stem anatomy Type A ..... sect. **Verbena**

1. Inflorescence cymose, with spikes in definite 3's; spikes subtended or not by foliaceous bracts, middle spike sessile or subsessile to pedunculate; stem anatomy Type A or B.

2. Spikes not subtended by foliaceous bracts; stems usually sharply 4-angled or (in ser. *Litorales*) some not; leaves indistinctly petiolate through attenuate leaf bases; stem anatomy mostly Type B ..... sect. **Verbenaca**

2. Each spike subtended by foliaceous bracts; stems not sharply 4-angled; leaves distinctly petiolate from truncate to cuneate leaf bases; stem anatomy Type A ..... sect. **Amphepeiros**

A character of fruit morphology appears to be predictive, as inferred from its consistent correlation with others in the distinction of natural groups. In some species, the developing fruit is essentially flat at the apex, and the style base is inserted at that level, at the juncture of the four nutlets. When the nutlets separate at maturity, the commissural faces appear to extend to the very tip of the nutlets. In other species, the style base is inserted in a depression in the middle of the nutlets, and when the nutlets separate at maturity, the dorsal side (the outer) of the nutlets is higher than the ventral side (the inner, with the commissural face), giving the appearance that the commissural face does not reach the nutlet apex.

Basis of the study

Thirty-two species occur in the FNANM flora area, and I also have studied representatives of almost all of the rest of the species. The present report summarizes observations based on study of the entire collections of *Verbena* sensu stricto (all geographic areas) from the following institutions: ARIZ (800 collections), BRIT-SMU (ca. 1000), MO (ca. 1800), NLU (ca. 800), and TEX-LL (ca. 1200, the Moldenke Verbenaceae collection). The ability to study additional type specimens through online images from F, GH, NY, US, and others has been especially useful. In addition to the FNA treatment (32 species, submitted), documentation is provided for various taxonomic decisions in a series of collateral papers (Nesom 2010a, 2010b, 2010c, 2010d, 2010e, 2010f, 2010g).

The native geographic range of each species is broadly characterized below as USA, Mexico, Central America, or South America. If a species occurs in more than one of these areas, the area of widest distribution is listed first.

VERBENA L., Sp. Pl. 1: 18. 1753; Gen. Pl. ed. 5, 12. 1754. **LECTOTYPE** (Jarvis et al., List Linn. Gen. Names Types, 98, 1993): *Verbena officinalis* L.

1. **SECTION** *VERBENA*

Stems not sharply 4-angled; leaves broad to narrow, petiolate or basally attenuate, lobed or unlobed, margins serrate; inflorescence paniculate, with spikes usually not in definite 3's; spikes not subtended by foliaceous bracts, all spikes usually pedunculate; fruits remote to densely overlapping at maturity. Stem anatomy Type A.

1a. Series *VERBENA*

Verbena [unranked] *Schizophyllae* Walpers, Repert. Bot. Syst. 4: 23. 1845. **LECTOYPE** (designated here): *Verbena officinalis* L.

Verbena [unranked] *Officinales* Small, Man. S.E. Fl. 1135. 1933. **TYPE**: *Verbena officinalis* L.

Plants taprooted or fibrous-rooted; stems erect at the base, sometimes apparently strongly 4-angled (perhaps similar to those of sect. *Verbenaca*?); leaves petiolate to subpetiolate, lobed to unlobed, blades thin, veins not impressed adaxially, margins serrate with acute teeth, not revolute; spikes solitary to few, with a tendency to occur in pairs, especially at the proximal 1–2 nodes of the inflorescence, fruits remote or becoming remote proximally; floral bracts usually shorter than the calyx or equal; rachis glandular or eglandular; commissural faces reaching the nutlet tip.

Verbena officinalis L. Europe; $2n = 14, 28, 42, 56$
Verbena supina L. Europe; $2n = 14$

Verbena gaudichaudii (Briquet) P.W. Michael Australia
Verbena macrostachya F. Mueller Australia
Verbena sororia D. Don Australia/Africa

Verbena madrensis Nesom Mexico
Verbena menthifolia Bentham Mexico, USA; $2n = 42$

Verbena grisea Rob. & Greenm. South America (Galapagos Islands)
Verbena demissa Moldenke South America (Ecuador)
Verbena caniuensis Moldenke South America (s Brazil)
Verbena filicaulis Schauer South America (Brazil, São Paulo)
Verbena gracilescens (Chamisso) Herter South America (Argentina, Bolivia, Paraguay, Uruguay); $2n = 42$
Verbena swiftiana Moldenke South America (Argentina, Misiones; Brazil, Rio Grande do Sul)
Verbena townsendii Svenson South America (Ecuador, Galapagos Islands)

The widely dispersed nativity of ser. *Verbena*, as constituted here, is unusual compared to other groups of the genus, which are geographically more coherent, and suggests that the geographical subsets need to be examined for the possibility of greater evolutionary independence. Significant differences between *V. officinalis* and *V. supina* suggest that even they are not most closely related to each other. The South American species placed here also constitute a heterogeneous group, morphologically and geographically.

Munir (2002) treated a group of morphologically and geographically distinct Australian population systems at varietal rank within *Verbena officinalis*. Michael (1997) recognized three of these taxa at specific rank (as above), distinct from naturalized *V. officinalis*, and the other two probably should treated similarly (see comments in Nesom 2010b). One of these Australian entities is naturalized in Africa (or vice versa); another may be naturalized in Mexico (Chiapas) and Guatemala, or else the latter plants represent an undescribed species (Nesom 2010b). Reported variability in ploidy level (diploid, tetraploid, hexaploid, octoploid) gives plausibility to the view that

differentiation within *V. officinalis* sensu lato may include discrete evolutionary entities appropriately recognized by formal nomenclature.

O'Leary et al. (2010) have indicated that *Verbena sororia* D. Don and *V. officinalis* var. *natalensis* Hochst. ex C. Krauss are the correct names at specific and varietal rank for the taxon treated in recent literature as *Verbena africana* (R. Fernandes & Verdcourt) P.W. Michael and *V. officinalis* var. *africana* (R. Fernandes & Verdcourt) Munir. O'Leary et al. treat it at varietal rank but have included other segregates, including the Australian taxa, as synonyms of typical *V. officinalis*.

Verbena grisea, an endemic of the Galapagos Islands, is distinct in its small, highly dissected leaves evenly distributed along the stems, stems and leaves and stipitate-glandular and grayish with densely hispid-hirsute vestiture, spikes elongate and very slender, and tiny flowers and fruits (corolla limb ca. 2 mm in diam., calyces 1.8–2 mm long, nutlets 1–1.2 mm long) slightly overlapping in fruit and relatively compactly arranged. The spikes mostly in pairs are like those of ser. *Verbena*, as are the nutlet commissural faces reaching the very tip. Its placement here is provisional but provides a basis for a hypothesis regarding its occurrence in the Galapagos, especially since it would be anomalous within any of the South American groups. In addition to images of the holotype and isotype (GH!), I have examined the following: Galápagos Islands: Duncan Island, rare around 1250 ft, 15 Aug 1905-06, *Stewart 3316* (CAS photo-LL!); Pinzon [Isla Pinzon = Duncan Island], near summit, 1200 ft, rare, fls light blue, to 70 cm, Sep 1975, *van der Werff 2322* (LL!).

Verbena demissa is endemic to Andean Ecuador (known from provinces Azuay, Cañar, and Pichincha). It is distinctive in morphology: stems numerous, prostrate and sometimes apparently rooting at the nodes, radiating from a thick, woody taproot; stems and rachises sparsely strigillose and sparsely stipitate-glandular; leaves small (6–20 mm), short-petiolate, obovate or elliptic-obovate to oblanceolate, the margins serrate with 2–3(–5) pairs of coarse teeth or shallow lobes; spikes relatively short (1–7 cm) and few-flowered, mostly solitary, less commonly with paired proximal spikes, the fruits becoming remote and somewhat divergent; flowers small (limbs ca. 2 mm in diam.); and fruits 1.6–1.8 mm, with commissural faces reaching the nutlet tips. *Verbena demissa* is similar to other species of the group in features of habit, stem anatomy (fide O'Leary et al. 2010) and morphology, glandular vestiture, the mostly solitary, short and few-flowered spikes, and nutlet morphology.

Verbena cantuensis is distinctive in its creeping habit and inflorescence reduced to a single spike, habital features shared with the geographically similar *V. filicaulis*. O'Leary et al. (2007) further discussed the distinctive inflorescence of *V. cantuensis*. On the other hand, its ovate-orbicular, coarsely serrate, narrowly petiolate leaves are unusual in ser. *Verbena*.

Verbena filicaulis is unusual among species of South American *Verbena* in its deeply 3-parted or pinnately 5-parted leaves, especially in combination with its apparently rhizomatous habit, solitary spikes, and larger flowers and fruits,. O'Leary et al. (2007) allied *V. filicaulis* with the species placed here in sect. *Amphepeiros* ser. *Austrobrasilienses*.

Verbena swiftiana Moldenke is similar to *V. filicaulis* in its deeply 3-lobed (with narrow divisions) to coarsely toothed lower and mid-cauline leaves and short, few-flowered, mostly unbranched spikes with remote fruits. The stems are glabrous, mostly unbranched, and often procumbent and rooting at the nodes. The type (isotype: NY digital image!) and the few other known collections from northeastern Argentina (Misiones), with one collection from immediately adjacent Brazil (Rio Grande do Sul).

Verbena gracilescens is a common and abundant species of central and southeastern South America (Argentina, Bolivia, Paraguay, Uruguay). It characteristically produces relatively short

(mostly 5–15 cm), very slender spikes with remote fruits extending to the base or nearly so (essentially without peduncles). The inflorescence is dichotomously branched, but often irregularly so. The stems are branching, sometimes decumbent and nodally rooting, and glabrous or very sparsely strigillose along the angles. Flowers are very small (calyces 1.2–1.5 mm), and the leaves are sharply serrate and often tripartite, especially the basal to mid-cauline.

In their characteristic morphology, *Verbena swiftiana* and *V. gracilescens* are conspicuously different, but O'Leary et al. (2010) have treated them as conspecific varieties, apparently emphasizing several cited specimens (without locality data) that are said to represent "una gradación continua" between the two. I have not seen the putative intergrades, but interspecific hybrids are not unsual in *Verbena* and such have not been interpreted in other instances as evidence of conspecificity. O'Leary et al., however, did not include Misiones, Argentina, or any of Brazil in the range of *V. gracilescens*, thus its geographic range, apparently allopatric with that of *V. swiftiana*, would preclude hybridization. The putative intergrades cited possibly may be populational variants within *V. gracilescens*.

Moldenke (1968, 1971) recognized *Verbena townsendii*, *V. galapagosensis* Moldenke, *V. stewartii* Moldenke, and *V. glabrata* var. *temuispicata* Moldenke as native taxa of the Galapagos Islands. From study in herbarium and field, Van der Werff (1977) concluded that they all belong to one single, extremely variable species (by far the most variable in the whole genus, in my observations of collections at MO and TEX-LL), the oldest name being *V. townsendii*. According to Van der Werff, differences in leaf width and lobing apparently result from habitat differences, position on the stem, and maturation of the plants—juvenile leaves usually are broader. Forms of *V. townsendii* are very similar to *V. gracilescens*.

1b. Series SIMPLICES Nesom, ser. nov. Type: *Verbena simplex* Lehm.

Foliis sessilibus angustis nonlobatis, spicis 1 vel paucis fructibus dense superpositis, vestimento eglanduloso, et nuculis superficiebus commissuralis apices attengentibus distinctus.

Plants taprooted; leaves linear to narrowly lanceolate or narrowly oblong-oblanceolate, sessile, unlobed, margins few-toothed, not revolute, blades thick with veins not impressed adaxially; spikes mostly 1 or few from proximal branches, fruits remaining dense and overlapping; floral bracts shorter than the calyces; rachis eglandular; commissural faces apparently extending completely to the nutlet tips.

Verbena simplex Lehman USA; $2n = 14$

Verbena simplex has no apparent close relatives, at least in eastern North America. It is similar to *V. carnea* in its tendency to produce sessile, unlobed leaves and fruits with commissural faces extending completely to the nutlet tips.

O'Leary et al. (in press) have treated *Verbena orcuttiana* as conspecific with *V. simplex*. The two differ in growth habit, vestiture, leaf arrangement, and floral features; they are very different in ecology and their native geographic ranges at their closest point are disjunct by more than 1100 miles. *Verbena orcuttiana* has many similarities with *V. californica* and *V. abramsii*, and those three species are treated here as ser. *Californicae*. Given the apparently isolated position of *V. simplex* in the eastern USA, it would be reasonable, at least as a hypothesis, to consider the possibility that it is closely related to ser. *Californicae*.

1c. Series *CONNATICARPAE* Nesom, ser. nov. **TYPE**: *Verbena carnea* Medikus

Duratione perenni habitu rhizomato, foliis sessilibus, spicis plerumque solitariis, floribus relative amplis distinctus, et nuculis connatis non discedentibus ad maturitatem.

Plants rhizomatous; leaves sessile, oblong-spatulate, unlobed, margins closely serrate to irregularly crenate-serrate, revolute, blades thick with veins impressed adaxially; spikes mostly 1 or few, slender, fruits becoming remote; floral bracts usually shorter than the calyx or equal; rachis eglandular; nutlets connate, not separating at maturity, commissural faces apparently extending completely to the nutlet tips.

Verbena carnea Medikus USA

Sanders (2001) hypothesized that *Verbena carnea* is close to *V. stricta* (here placed in ser. *Candelabrae*), but the rhizomatous habit and the thickened, unlobed leaves with closely serrate margins are without a close match elsewhere in the genus. The reduced inflorescence and the connate nutlets are specialized features, suggesting that *V. carnea* is derived from some North American group. There is a tendency in a number of North American species for the nutlets to remain adherent until very late in ontogeny, and the developmental persistence of this feature in *V. carnea* is hardly a character that would justify segregation at generic rank.

O'Leary et al. (2010) have adopted *Verbena caroliniana* Michx. (1803) as the correct name for this species, as preferred over the earlier *V. carnea* Medikus (1784). Comments and a neotype justifying retention of the Medikus name are provided by Nesom (2010d).

1d. Series *LEPTOSTACHYAE* Schauer in DC., Prodr. 11: 545. 1847. **LECTOTYPE** (designated here): *Verbena urticifolia* L. Troncoso (1974, p. 311) designated *Verbena officinalis* as the lectotype of series *Leptostachyae*, but *V. officinalis* is automatically the type of series *Verbena*.

Plants taprooted or fibrous-rooted; leaves petiolate, unlobed, margins serrate with acute teeth, blades thin with veins not impressed adaxially; spikes numerous, often strictly in 3's at lower nodes, slender, fruits distantly remote; floral bracts usually shorter than the calyx or equal; rachis eglandular; commissural faces extending to very tip of nutlets.

Verbena carolina L. Mexico, sw USA, Central America; $2n = 14$
Verbena ehrenbergiana Schauer Mexico; $2n = 14$
Verbena scabra Vahl USA, West Indies, Mexico
Verbena urticifolia L. USA; $2n = 14$

The plants of ser. *Leptostachyae* are easily recognizable by their eglandular vestiture, numerous, long, very slender spikes with remote fruits, tiny corollas, and nutlets with commissural faces extending to very tips (see Nesom 2010 c).

1e. Series *CANDELABRAE* Nesom, ser. nov. **TYPE:** *Verbena stricta* Ventenat
Verbena [unranked] *Hastatae* Small, Man. S.E. Fl. 1135. 1933. **TYPE**: *Verbena hastata* L.

Foliis latis grosse serrato et spicis numerosis crassiusculis fructibus dense superpositis distinctus.

Plants taprooted or fibrous-rooted; leaves distinctly petiolate to subsessile, unlobed, margins usually coarsely serrate to incised with acute teeth, blades thickened with veins impressed adaxially; spikes numerous and clustered from distal nodes, thick, fruits densely overlapping; floral bracts usually shorter than the calyx or equal; rachis eglandular; commissural faces extending to very tip of nutlets.

Verbena hastata L. USA; $2n = 14$
Verbena macdougalii Heller USA, Mexico; $2n = 14$
Verbena stricta Ventenat USA; $2n = 14$
Verbena xutha Lehman USA; $2n = 42$

Verbena stricta and *V. macdougalii* are very similar between themselves and probably related as sister species. *Verbena hastata* stands apart in its reduced vestiture and relatively long-petiolate leaves with serrate margins; a close relationship with ser. *Leptostachyae* should be investigated. *Verbena xutha* is provisionally placed here, emphasizing its eglandular vestiture, spikes arising from distal branches and often remaining relatively compact, and nutlets with commissural faces extending to very tip of nutlets. The laciniate leaves of *V. xutha*, however, are more similar to some of those of ser. *Plicatae*. The polyploid chromosome number of *V. xutha* at least allows the possibility that it incorporates more than one genome.

1f. Series *BRACTEATAE* Nesom, ser. nov. **TYPE**: *Verbena bracteata* Lag. & Rodr.
Verbena [unranked] *Bracteosae* Small, Man. S.E. Fl. 1135. 1933. **TYPE**: *Verbena bracteata* Lag. & Rodr. (incl. *Verbena bracteosa* Michx.)

Foliis latis serrato-incisis, spicis densis bracteis longi-protrusis, et fructibus ad maturitatem plus minusve remotis distinctus.

Plants taprooted or fibrous-rooted; leaves petiolate to subsessile, often 3-lobed, margins serrate to deeply incised with acute teeth, blades relatively thin, veins not impressed adaxially; spikes few, thick, fruits densely overlapping but sometimes becoming somewhat remote at maturity; floral bracts becoming much longer than the calyx and corolla; rachis eglandular; commissural faces extending to very tip of nutlets.

Verbena bracteata Lagasca & Rodr. USA, Mexico; $2n = 14, 28$

Specializations of *Verbena bracteata* in habit (prostrate) and inflorescence (mostly solitary, elongate spikes with greatly enlarged bracts and relatively large fruits) give the species a distinctive appearance. The petiolate, incised leaves, eglandular vestiture, and nutlets with commissural faces extending completely to the tip are similar to those of *V. xutha*.

1g. Series *HALEAE* Nesom, ser. nov. **TYPE**: *Verbena halei* Small

Foliis crassibus venis adaxialiter impressis marginibus revolutis caulium lobatis et spicis numerosibus fructibus late remotis ad maturitatem distinctus.

Plants taprooted; leaves petiolate to subpetiolate, basal lobed to unlobed, cauline lobed, margins serrate with acute teeth, blades thick, veins impressed adaxially; spikes numerous, slender, fruits becoming remote; floral bracts usually shorter than the calyx or equal; rachis eglandular; commissural faces ending below the nutlet tips.

Verbena halei Small USA, Mexico; $2n = 14$

Verbena halei has been treated as element of *V. officinalis*, as *V. halei* subsp. *halei* (Small) S. Barber, but the two rarely if ever have the opportunity even to hybridize, much less to intergrade. The consistent morphological differences and continental disjunction in native range support the treatment of *V. halei* at specific rank.

An individual of *Verbena menthifolia* from Arizona studied by Yuan and Olmstead (2008b) was heterozygous at both the PHOT1 and PHOT2 nuclear gene loci, and the gene trees indicated that the individual was of hybrid origin, with *V. halei* as one of the putative parental species.

1h. Series *PLICATAE* Nesom, ser. nov. TYPE: *Verbena plicata* Greene

Foliis latis plerumque 3-lobatis segmentis inciso-dentatis venis saepe abaxialiter prope margines albidis et spicis 1 vel paucis distinctus.

Plants taprooted; leaves usually petiolate, relatively broad (oblong-ovate or obtusely elliptic-ovate), cauline sometimes subclasping, often 3-parted, margins coarsely serrate to incised-serrate or pinnately lobed-serrate, blades thick, veins impressed adaxially, often whitish abaxially near the margins; spikes 1 or few, dense with overlapping fruits to elongate and slender with fruits becoming remote; floral bracts usually shorter than the calyx or equal; rachis usually glandular; commissural faces ending below the nutlet tips (except in *V. xutha*).

Verbena cloverae Moldenke USA; $2n = 14$
Verbena plicata Greene USA, Mexico; $2n = 14$
Verbena runyonii Moldenke USA; $2n = 14$
Verbena lasiostachys Link (incl. *V. robusta* Greene, *V. prostrata* W.T. Ait.) USA, Mexico; $2n = 14$

Among these species, *Verbena plicata* and *V. cloverae* share a distinctive feature of the nutlets—the commissural faces are bullate with low plates densely packed and perhaps connate, forming essentially an unbroken white surface. The Californian *V. lasiostachys* appears to belong in ser. *Plicatae* but is distinct in geography compared to the others, which are mostly in the south-central USA. O'Leary et al. (2010) treated *V. runyonii* as a synonym of *V. neomexicana* var. *hirtella* Perry.

1i. Series *CALIFORNICAE* Nesom, ser. nov. TYPE: *Verbena californica* Moldenke

Foliis plerumque oblanceolatis dentatis, fructibus dense imbricatis vel remotis, rhachidibus calycibusque glandulosis, et nuculis superficiebus commissuralis apices attengentibus distinctus.

Plants taprooted; leaves elongate, not lobed, without distinct petioles, margins toothed, revolute, surfaces not glossy, veins impressed adaxially; spikes 1 or 2–5 from medial to distal branches, relatively thin, fruits not overlapping or densely overlapping but becoming remote proximally; floral bracts shorter than the calyx or equal; rachises and calyces glandular; commissural faces extending completely to the nutlet tips

Verbena abramsii Moldenke USA
Verbena californica Moldenke USA
Verbena orcuttiana Perry Mexico

These three species are very similar in aspect to those of ser. *Tricesimae*. Their recognition here as a separate group emphasizes the distinctive nutlet morphology and their Californian geography (Nesom 2010 f, in manuscript).

1j. Series *TRICESIMAE* Nesom, ser. nov. TYPE: *Verbena canescens* Kunth

Foliis elongatis pinnatifidus vel penitus dentatis, laminis incrassatis venis adaxaliter impressis marginibus revolutis, spicis 1 vel paucis relative tenuibus fructibus plerumque proxime remotis distinctus.

Plants taprooted; leaves elongate, pinnatifid to deeply toothed (incised-pinnatifid or incised dentate, varying to subentire), blades thickened, veins impressed adaxially, margins revolute, surfaces glossy; spikes 1 or few, relatively thin, fruits becoming remote proximally; floral bracts shorter than the calyx or equal; rachises glandular or eglandular; commissural faces not reaching the nutlet apex.

Verbena canescens Kunth Mexico, USA; $2n = 14$
Verbena gracilis Desfontaines Mexico, USA
Verbena hirtella (Perry) Nesom, ined. Mexico, USA; $2n = 14$
Verbena jessicae Nesom & Hinton, ined. Mexico
Verbena johnstonii (Moldenke) Nesom Mexico
Verbena livermorensis Turner & Nesom, ined. USA, Mexico
Verbena moranii Nesom, ined. Mexico
Verbena neomexicana Small Mexico, USA; $2n = 14$
Verbena nitens Nesom, ined. Mexico
Verbena perennis Wooton USA; $2n = 14$
Verbena pinetorum Moldenke Mexico, USA
Verbena subuligera Greene Mexico
Verbena xylopoda (Perry) Nesom, ined. USA, Mexico

The sectional epithet alludes to the 30th parallel, which most of the species are near. *Verbena canescens* and *V. gracilis* have wide ranges compared to the others, from the southwestern USA to south-central Mexico. *Verbena abramsii, V. californica* and *V. orcuttiana*, at the northwestern corner of this group, stand apart from the other species in their elongate, serrate leaves and commissural faces of the nutlets extending completely to the nutlet tips—these perhaps represent a distinct group. The species of ser. *Tricesimae* are treated in detail in Nesom (2010g, in manuscript) and Nesom and Hinton (2010, in manuscript; *V. jessicae*), where the species noted above as "ined." will be formally described or delimited.

Sanders (2001) hypothesized that *Verbena neomexicana* is part of the species group that includes *V. menthifolia*, and indeed they have similarities in habit. *Verbena menthifolia*, however, and its putatively close relative *V. madrensis* have thinner leaves with non-revolute margins and veins not impressed adaxially, and the commissural faces generally extend completely to the nutlet tips.

2. SECTION *AMPHEPEIROS* Nesom, sect. nov. TYPE: *Verbena glabrata* Kunth
Inflorescentiis cymosis spicis in 3s, quoque spica per folia vel bracteas foliaceas subtenta, et foliis latis distincte petiolatis e basi truncatis vel cuneatis marginibus grosse serratis distinctus.

Stems not sharply 4-angled (Type A anatomy); leaves broad, distinctly petiolate from truncate to cuneate leaf bases, unlobed, margins coarsely serrate; inflorescence cymose, with spikes in definite 3's; each spike subtended by foliaceous bracts, often with the middle spike sessile or subsessile to short-pedunculate; fruits usually densely overlapping at maturity.

2a. Series PACIFICAE Nesom, ser. nov. TYPE: *Verbena glabrata* Kunth
Distributione geographica plerumque secus oceanum pacificum distinctus.

Verbena glabrata Kunth South America (Bolivia, Ecuador, Columbia, Peru)
Verbena macrodonta Perry Mexico (Baja California Sur)
Verbena recta Kunth Mexico
Verbena sedula Moldenke South America (Galapagos Islands)

Species of ser. *Pactficae* are autochthonous to both the South American and North American continents (also see ser. *Pachystachyae* regarding *V. sphaerocarpa*; ser. *Verbena* is the only group hypothesized here to be more widepread). The separation of ser. *Brasilienses* and ser. *Pacificae*, based on geography, hypothesizes that other distinctions remain to be discovered; a clear morphological difference is not apparent, but the geographically-based names provide reference to the groups. It also is acknowledged that the separation may be arbitrary.

Verbena macrodonta is one of a number of endemic species of the oak and pine-oak woodlands of the Sierra de la Laguna of Baja California Sur. Pine-oak forests closest to those of the Sierra de la Laguna are in the trans-volcanic ranges of southeast and south-central Mexico, the "Serranias Meridionales" floristic province, fide Rzedowski (1978). Pine-oak forests of northern Baja California (Sierra Juarez, Sierra San Pedro Mártir) are more closely related floristically to the USA.

I have seen only the holotype (MO!) and isotype (US digital image!) of *Verbena macrodonta*, but the distinctive leaf morphology and inflorescence structure, as well as its geography, justify its placement among these species. The leaves are large, broadly lanceolate to oblong-lanceolate with coarsely serrate margins and truncate or rounded bases and distinct petioles, and the spikes are dense, subtended by bracts, and distinctly in 3's. *Verbena macrodonta* and *V. recta* both are unusual in sect. *Amphepetros* because of their pedunculate spikes. O'Leary et al. (2010) have placed *V. macrodonta* as a synonym of *V. officinalis*.

Verbena glabrata is native to western South America. O'Leary et al. (2007) identified and cited far-disjunct collections from Mexico (Michoacan, Puebla, and Veracruz) as *V. glabrata*, but these Mexican plants are *V. recta*. O'Leary et al. (2010) have recognized *V. recta* as distinct but without clarifying their earlier equation of it with *V. glabrata*. I have seen collections of *V. recta* from the Mexican states of Distrito Federal, Edo. México, Michoacan, Morelos, Nuevo León, Oaxaca, and Puebla. The populations in Nuevo León appear to be disjunct from the others but morphologically inseparable.

Collections identified as *Verbena glabrata* from the southernmost portion of its range (Depto. Arequipa in Peru) are of prominently glandular plants with trilobed and more elongate leaves than characteristic elsewhere. It is probable that these represent an undescribed species.

2b. Series AUSTROBRASILIENSES Nesom, ser. nov. TYPE: *Verbena hirta* Sprengel
Distibutione geographica plerumque in Brasilia australi distinctus.

Verbena hirta Sprengel South America (s Brazil, ne Argentina)
(tentatively including var. **hirta** and var. **gracilis** Dusén)
Verbena lobata Velloso South America (s Brazil)
(tentatively including var. **lobata** and var. **glabrata** Moldenke)
Verbena subpetiolata N. O'Leary South America (s Brazil)

All three species of ser. *Austrobrasilienses* are centered in southernmost states of Brazil, Paraná, and Rio Grande do Sul, hence the series epithet. This is a morphologically heterogeneous assemblage needing further study.

3. SECTION *VERBENACA* Walpers, Repert. Bot. Syst. 4: 14. 1845. **LECTOTYPE** (designated here): *Verbena bonariensis* L. Sect. *Verbenaca* of Walpers included *Verbena*, *Glandularia*, and *Junellia*. The lectotype is chosen here to represent to restrict the section to *Verbena* sensu stricto. Schauer (1847) followed Walpers in his broad concept of sect. *Verbenaca*, placing *V. officinalis* within sect. *Verbenaca* series *Leptostachyae*.

Stems usually sharply 4-angled (Type B anatomy); leaves broad to narrow, indistinctly petiolate through attenuate leaf bases, unlobed, margins coarsely serrate to subentire; inflorescence cymose, with spikes in definite 3's; spikes not subtended by foliaceous bracts, often with the middle spike sessile or subsessile to pedunculate; fruits densely overlapping or becoming remote at maturity.

3a. Series *PACHYSTACHYAE* Schauer in DC., Prodr. 11: 539. 1847. **LECTOTYPE** (Troncoso 1974, p. 311): *Verbena bonariensis* L. O'Leary et al. (2007, p. 580) cited "serie *Pachystachyae* subserie *Pachystachyae* Schauer," perhaps supposing that the subseries was automatically established. "Subseries *Pachystachyae*" is not a legitimate name.

Verbena [unranked] *Foliosae* Walpers, Repert. Bot. Syst. 4: 18. 1845. **LECTOTYPE** (designated here): *Verbena bonariensis* L.

Verbena [unranked] *Micranthae* Walpers, Repert. Bot. Syst. 4: 18. 1845. **LECTOTYPE** (designated here): *Verbena bonariensis* L.

Verbena [unranked] *Holophyllae* Walpers, Repert. Bot. Syst. 4: 18. 1845. **LECTOTYPE** (designated here): *Verbena bonariensis* L.

Verbena [unranked] *Bonarienses* Small, Man. S.E. Fl. 1135. 1933. **TYPE**: *Verbena bonariensis* L.

Verbena [unranked] *Venosae* Small, Man. S.E. Fl. 1135. 1933. **TYPE**: *Verbena rigida* Spreng.

Fruiting spikes relatively short and thick, the central sessile to subsessile, with fruits usually densely overlapping at maturity. Leaves unlobed.

Verbena alata Otto ex Sweet South America
Verbena bangiana Moldenke South America
Verbena bonariensis L. South America; $2n = 14, 28$
Verbena brasiliensis Velloso (incl. *V. intercedens* Briquet) South America
Verbena ephedroides Chamisso South America
Verbena goyazensis Moldenke South America
Verbena hispida Ruiz & Pavon South America; $2n = 14$
Verbena incompta P.W. Michael South America
Verbena intermedia Gillies & Hooker ex Hooker South America; $2n = 28, 35, 56$
Verbena lindbergii Moldenke South America
Verbena ovata Chamisso South America; $2n = 72$
Verbena rigida Sprengel South America; $2n = 42$
Verbena sagittalis Chamisso South America
Verbena sphaerocarpa Perry Mexico (Socorro Island)
Verbena valerianoides Kunth South America

Verbena rigida was observed by O'Leary et al. (2007) to have Type B stem morphology, unlike the rest of the section. It also is unusual in it rhizomatous habit, but in features of the inflorescence it is similar to the species placed here in ser. *Verbenacae*.

Verbena sphaerocarpa is tentatively recognized at specific rank (Nesom 2010a). It is endemic to Socorro Island (about 600 kilometers west of the coast of Colima, Mexico) but is very similar to *V. brasiliensis* and probably derived from it.

Verbena valerianoides is a distinctive species apparently endemic to montane Colombia (the type from Bogotá, P fiche!) It produces sessile, non-clasping, narrowly lanceolate to oblong-lanceolate, entire leaves and short, thick spikes, the central one sessile. O'Leary et al. (2007) considered this a "doubtful taxon" but I have seen recent collections from the departments of Boyacá, Cundinamarca, and Nariño.

Verbena bangiana was treated by O'Leary et al. (2007) as *V. hispida* var. *obovata* (Moldenke) O'Leary, who noted that they did not consider differences in vestiture and floral dimensions between the two taxa as "sufficiently important in *Verbena*" to separate them as distinct species. Collections of each are numerous and intermediates appear to be rare, suggesting that the two are reproductively isolated.

Verbena goyazensis (Bull. Torrey Bot. Club 77: 404. 1950. **TYPE**: **Brazil.** Goiás. Rio do Peixe, 8 Jul 1949, *G. Hashimoto 663* [holotype: SP, fragment-NY digital image!]) has broad, sessile, serrate leaves and very short, congested spikes in 3's—it appears to be remarkably distinct in its leaves with deeply reticulate-excavate abaxial surfaces. It has been included by O'Leary et al. (2010) as a "doubtful taxon."

3b. Series *LITORALES* Nesom, ser. nov. **TYPE**: *Verbena litoralis* Kunth

Spicis fructiferis relative elongatis gracilibusque fructibus proximalibus remotis ad maturitatem et foliis nonlobatis distinctus.

Fruiting spikes elongate and slender, the central pedunculate, with fruits becoming remote at maturity, at least proximally; leaves unlobed.

Verbena litoralis Kunth South America (western); $2n = 28, 42, 56$
Verbena montevidensis Sprengel South America (southeastern); $2n = 21, 42$

Both of these species, as currently identified, appear to be polymorphic. Potential correlations between ploidy level and morphology apparently have not been investigated.

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TAXONOMIC NOTES ON *VERBENA BONARIENSIS* (VERBENACEAE) AND RELATED SPECIES IN THE USA

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ABSTRACT

Verbena bonariensis, as previously recognized in the USA, is here recognized to include two distinct species, both native to South America and both widespread in geographic range. *Verbena incompta* is the more common of the two and is characterized by relatively smaller flowers and eglandular vestiture; *V. bonariensis* sensu stricto has larger, showy flowers and glandular stems, peduncles, and calyces. *Verbena littoralis* has sometimes been recognized to occur in the USA, but such records have proved to be *V. brasiliensis* and *V. montevidensis*. *Verbena litoralis* sensu stricto is native to northwestern South America, Central America, and Mexico, apparently not reaching the USA even as an adventive. *Verbena montevidensis* is documented to be naturalized in Alabama, Arkansas, Florida, Georgia, Louisiana, Oregon, and Texas. Each of these species is distinctive in North America.

KEY WORDS: *Verbena bonariensis*, *V. incompta*, *V. brasiliensis*, *V. litoralis*, *V. montevidensis*, Verbenaceae, taxonomy, USA

Recent studies of *Verbena bonariensis* L. and *V. brasiliensis* Vell. and close relatives (Yeo 1990; Michael 1995, 1997, 2008; Munir 2002; O'Leary et al. 2007) have disagreed in typification and concepts of morphological definition and taxonomic rank. These taxa are native to South America but have become widely naturalized worldwide in tropical and subtropical regions. They have been studied in preparation of a taxonomic treatment of *Verbenaceae* for the developing Flora of North America series, and the results are reported here at a greater level of detail than will be included in the FNA comments. Of the taxa considered, Perry (1933) recorded the presence of *V. bonariensis*, *V. brasiliensis*, and *V. litoralis* Kunth in the USA; *V. montevidensis* Spreng. has since been recognized to occur here; and the occurrence in the USA of a species recently segregated from *V. bonariensis* is unequivocally documented here for the first time. The recent overview by Sanders (2001) included comments on *V. bonariensis*, *V. brasiliensis*, *V. litoralis* and *V. montevidensis*.

Detailed typification has been provided in studies cited above. Some of that is repeated or restudied here for ease of reference in documentation of present interpretation and because some of the names in synonymy may be involved in future arrangements to portray the taxonomy, especially with reference to *V. litoralis* and its closest relatives. Also, disagreements exist between the present study and previous ones.

Variation in *Verbena bonariensis* sensu lato and the status of *V. incompta*

Yeo (1990) observed that among plants generally identified as *Verbena bonariensis*, which is characterized by clasping leaf bases, some are more similar to *V. brasiliensis* (which has tapering leaf bases) in a suite other features, and he accommodated these latter plants by broadening the concept of *V. brasiliensis* to include plants with clasping bases. Shortly afterward, the *V. brasiliensis*-like plants (fide Yeo) with clasping leaf bases were formally described as *Verbena incompta* P.W. Michael

(Michael 1995), in recognition of their apparent evolutionary independence from both *V. bonariensis* and *V. brasiliensis*. The type of *V. incompta* is from Australia, where it is naturalized, but native to South America. Munir (2002) and O'Leary et al. (2007), in contrast, because of a different interpretation of the Linnaean type of *V. bonariensis*, considered *V. incompta* as synonymous with typical *V. bonariensis* and recognized the variants as *V. bonariensis* var. *conglomerata*. Munir and O'Leary et al. both characterized var. *conglomerata* as essentially the same in morphology as Michael's *V. incompta*. Var. *conglomerata* was treated by Michael, followed here, as a synonym of typical *V. bonariensis*.

Recognition of two entities within what previously was considered as *Verbena bonariensis* sensu lato is confirmed in the present study. Munir mapped var. *conglomerata* as sympatric in Australia with var. *bonariensis*, nearly identical in range, and observed that they are "easily separated"—especially by spike shape and corolla tube length. He did not note the occurrence of hybridization or integradation between the two. O'Leary et al. noted that although var. *conglomerata* is more restricted in native geographic range, it is sympatric in South America with typical *V. bonariensis*. The morphological description of var. *conglomerata* by O'Leary et al. was similar to Munir's—and apparently as with Munir, treatment of the two entities as conspecific varieties was based on the observation that their distinctions did not meet a criterion, unspecified, for recognition at specific rank ("Las differencias entre las dos variedades de *Verbena bonariensis* … lo cual no justifican la separación de este taxon a nivel especifico.").

Distinctions, as recognized and emphasized in the previous studies, between the two entities of *Verbena bonariensis* sensu lato are these. Diagnostic features observed in the present study are contrasted in the key further below.

Michael (1995, 2008)

a. Corollas prominently exserted from calyces, tubes 3.5–5 mm; peduncles and calyces stipitate-glandular; anthers inserted near middle of corolla tube, floral bracts shorter than calyces, mature nutlets 1.5–2.1 mm ..... **Verbena bonariensis**

a. Corollas only slightly exserted from calyces, tubes 2.5–3.5 mm; peduncles and calyces usually eglandular; anthers inserted in distal third of corolla tube, floral bracts longer than calyces, mature nutlets 1.2–1.5 mm ..... **Verbena incompta**

Munir (2002)

a. Spikes contracted into capitate or subcapitate clusters; corolla tube much protruding, ca. 1.5–2 times longer than the calyx; peduncles glandular ..... **Verbena bonariensis** var. **conglomerata**

a. Spikes subcylindric, aggregate but not in capitate or subcapitate clusters; corolla tube slightly exserted, mostly less than 2 times longer than the calyx; peduncles eglandular **Verbena bonariensis** var. **bonariensis**

O'Leary et al. (2007)

a. Corolla tubes generally more than 5 mm, nearly twice as long as the calyx, floral bracts with obtuse or subobtuse apices, generally shorter than the calyx; peduncles glandular; leaf blades generally narrowly elliptic to sublinear ..... **Verbena bonariensis** var. **conglomerata**

a. Corolla tubes rarely more than 5 mm, floral bracts with acute apices, equalling the calyx or longer; peduncles eglandular; leaf blades ovate-elliptic ..... **Verbena bonariensis** var. **bonariensis**

The present study documents the existence of both entities in the USA and concludes that their broad sympatry without intermediacy is evidence for reproductive isolation. Each is recognized here at specific rank. The interpretation of the identity of the type of *Verbena bonariensis* also is in agreement with Michael (1995, 2008) and the two appropriate names are *V. bonariensis* and *V. incompta*.

VERBENA BONARIENSIS L., Sp. Pl. 1: 20. 1753. **TYPE**: **[Argentina]**. "Habitat in agro Bonariensi" (this referred to the origin of the plant illustrated by Dillenius rather than the collection locality of the Linnaean type, as noted by Yeo, fide C. Jarvis). **LECTOTYPE** (Moldenke 1962a, p. 252, fide Jarvis 2007): Herb. Linn. No. 35.11 (LINN, digital image!). Michael (1995, 2008) reckoned that Yeo's lectotypification (1990) was to be preferred, but Jarvis chose the earlier one of Moldenke. In any case, both Yeo and Moldenke indicated that 35.11 should be the lectotype. Narrow leaves and long corolla tubes are evident in the digital image, placing the identity in agreement with observations of Yeo and Michael. Yeo studied the type material in London (BM and LINN) and his application of the name is unambiguous.

Verbena bonariensis var. *conglomerata* Briq., Ark. Bot. Stockh. 2: 10, t. 3b. 1904. **LECTOTYPE** (Munir 2002, p. 36): **Brazil**. Rio Grande do Sul: Porto Alegre, in pascuis siccis arenosis, 12 Oct 1892, *C.A.M. Lindman A.473* (S digital image!; isolectotypes: S digital image!).

Verbena intercedens Briq., Bull. Herb. Boissier, ser. 2(4): 1057. 1904. **LECTOTYPE** (O'Leary 2006, p. 496): **Paraguay**. Caraguatay, in campis humidis, 1898-1889, *E. Hassler 3324* (G; isotypes: G, K fide O'Leary). Syntype: Paraguay, *Hassler 6149* (B photo-MO!, MO!). The illustration of *V. intercedens* in O'Leary et al. (2007, Fig. 5) is an excellent portrayal of the species identified here as *V. bonariensis* L.; the accompanying description characterizes the floral bracts as "hispidas con pelos glandulares."

Verbena inamoena Briq. Bull. Herb. Boissier, ser. 2(4): 1058. 1904. TYPE: **Paraguay**. Tobaty, Aug 1899, *E. Hassler 3164* (holotype: G, isotype: SI). Not seen; synonym of *V. bonariensis* var. *conglomerata* fide O'Leary et al. (2007).

Verbena bonariensis var. *hispida* Moldenke, Phytologia 33: 374. 1976. TYPE: **Brasil**. Rio Grande do Sul: Villa Germanica, Mar 1906, *A. Bornmüller 647* (holotype: MO!; isotype: M). Not seen; synonym of *V. intercedens* fide O'Leary et al. (2007).

Plants annual, taprooted or with ligneous fibrous roots. **Stems** erect, 80–150 cm, hirsute to hirsutulous, densely so distally, sparsely to densely stipitate-glandular. **Leaves** persistent, basal and midstem oblong-lanceolate to oblong-oblanceolate, basally clasping and auriculate, 5–11 cm x 10–20 mm, distal (above midstem) becoming linear-lanceolate to linear-oblanceolate, veins impressed adaxially, both surfaces hirsutulous to hirsute-hirsutulous or hirtellous, usually sparsely to densely stipitate-glandular, margins sharply serrate, narrowly revolute; petioles absent. **Spikes** in 3s, forming compound cymes, the central mostly sessile on peduncles 0(–4) mm, inflorescence aspect corymbiform, comprising relatively compact and distinct clusters and subclusters, central and laterals dense and thick in fruit, 8–30 mm x 4–6 mm; floral bracts narrowly triangular to lanceolate or ovate-lanceolate, keeled, 2.1–2.8 mm, 1/2–3/4 as long as the calyces, margins ciliate. **Calyces** 3–3.5 mm, purplish, hirsutulous to hirsutulous-hirtellous or hirtellous, stipitate-glandular, lobes connivent. **Corollas** purple to blue-violet or pinkish, tubes 4–6(–7) mm, 1.5–2 mm longer than the calyces, limbs 2–5 mm in diam. **Nutlets** 1.5–1.9 mm, commissural faces extending to very tip of nutlets, densely papillate to papillate-bullate. $2n = 12, 14, 28$.

Flowering May–Jul(–Sep). Roadsides, fields, clearings, depressions, disturbed sites; 10–100 m; introduced in Ark., Calif., Ga., La., Mass.(?), Miss., Mo., N.Y., N.C., Oreg., S.C., Tenn.(?); native to South America (southern Brazil, Uruguay, Paraguay, northern Argentina); introduced also in Asia (Taiwan fide S. M. Chaw et al. 1986), Africa, Indian Ocean Islands (Mauritius), Pacific Islands (New Zealand), Australia.

Verbena bonariensis is easily recognizable, especially in vivo (fide numerous photos) where the long floral tubes are conspicuous, and even in the herbarium. Upon seeing the prominent flowers, examine the peduncles and calyx with a lens to confirm the presence of glandularity. The difference in leaf morphology also can be confirmed with a small set of specimens—leaves of *V. bonariensis* tend to be narrower than in *V. incompta*. In addition to the distinctions in the key, in *V. bonariensis* the non-glandular hairs are thinner and the plants apparently are generally shorter in stature and more clearly annual in duration. Described differences in shape and size of the inflorescence do not appear

to be consistent, except in the elongation of fruiting spikes. Within each species, South American plants are similar in variability to the North American ones.

Most internet photos of "*Verbena bonariensis*" show the typical form, which is cultivated for its showy, fragrant flowers. Photos of both species, from California plants, are shown on CalPhotos (http://calphotos.berkeley.edu). In the USA, however, the few collections of naturalized plants indicate that typical *V. bonariensis* occurs much less commonly than *V. incompta*.

Moldenke identified typical *Verbena bonariensis* as var. *conglomerata*. He cited (1962a, p. 267) only two collections of var. *conglomerata* from non-cultivated plants growing in the USA: **California**. Sonoma Co., Sebastopol, garden weed, 14 May 1961, *Noldeke s.n.* (LL); **Tennessee**. Knox Co., in the back yard of J.M. Brown, 1601 Lombard Place, probably a hybrid, 29 Jun 1954, *Hoss 18323* (TENN). Otherwise, plants apparently have been so identified in the USA only by Sorrie and Somers (1999), who noted the occurrence of "var. *conglomerata*" in **Massachusetts**. Hampshire Co.

Collections examined. **Arkansas**. Ashley Co.: P.O. Hamburg, damp woods, 250 ft, 11 Jun 1938, *Demaree 18637* (MO). **California**. Los Angeles Co.: San Bernadino Basin, alluvial fan of San Antonio Cayon, along Baseline Blvd, on S side of road between Monte Vista Ave. and Central Ave., presumably a waif, disturbed alluvial soil of parkway between road and old quarry fence, 12 May 2000, *Boyd et al. 10306* (TEX). Sonoma Co.: Sebastopol, garden weed, 14 May 1961, *A.M. Noldeki s.n.* (LL). **Georgia**. Jefferson Co.: Wrens, frequent on sandy loam, 15 Jun 1959, *Kral 9074* (VDB-2 sheets). **Louisiana**. Morehouse Par.: ditch beside Par. Rd. 5802, S of La. 134, 15 Jul 1977, *Thomas 54092* (NLU); weed in cemetery beside La. 834 N of Jones and W of US 165, 25 Jul 1983, *Thomas et al. 84586* (BRIT, NLU-2 sheets); edge of pine woods S of dirt road along Arkansas state line N of La. 834 and W of Jones, 4 Jun 1989, *Thomas 110,732* (BRIT, NLU). Jefferson Davis Par.: roadside ditch, US 90 ca 1 mi E of Jennings, 30 May 1986, *Allen 13120* (NLU). Vernon Par.: ca. 7 mi N of Pitkin, near Cooter's Bog, off La. 467, 19 Jun 2002, Allen 18970 (NLU). **Mississippi**. Hinds Co.: roadbank of Miss. 27 on hilltop W of Bear Creek Road, 10.3 mi NW of I-55 at Crystal Springs, 17 May 1983, *Thomas et al. 83445* (BRIT). Wilkinson Co.: along new gas line ROW in gorges N of Miss. 24, E of Lessley and ca. 10 mi W of Woodville, 17 Jun 1993, *Thomas 140,086* (NLU). **Missouri**. St. Louis Co.: St. Louis, 4500 block of Shaw Avenue, just W of RR crossing on S side of road, area of fill dirt storage, 9 Oct 2002, *Yatskievych et al. 02-77* (MO). **New York**. Bronx Co.: New York Botanical Garden, near Operations where soil and trees dumped, ca. 2 dozen plants on steep bank of gravelly soil, 6 Jul 1997, *Nee 47132* (TEX). **North Carolina**. Bladen Co.: weedy old field, NC Rte 41, 8.5 mi E of White Lake, 2 Jul 1950, *Fox and Boyce 3783* (SMU). Tyrrell Co.: 4 mi W of Columbia, edge of fields, 18 Aug 1957, *Reed 40224* (MO). **Oregon**. Linn Co.: weedy area by the holding ponds behind the OSU Salmon Disease Lab, just E of Corvallis, 61 meters, 9 Sep 2000, *Halse 5935* (BRIT). **South Carolina**. Barnwell Co.: Savannah River Operation Area (A.E.C.), Station 74, swamp flat at end of road, 4 Jun 1969, *Kelley 74* (MO). Charleston Co.: roadside near Charleston, Sep [without year], *Curtis 1963* (MO-2 sheets); Port of Charleston, wastes, 17 May 1979, *Reed 139497* (MO). Edgefield Co.: sandy peaty swale by intersect. US 25 and SC 121, 11 Aug 1995, *Kral 85469* (VDB). Greenville Co.: jct of Standing Spring Rd and Laurens Rd, 16 Jun 1974, *Boufford 14361* (MO). McCormick Co.: field near SC 28, 2 mi S of Plum Branch, 11 May 1957, *Radford 22293* (VDB).

VERBENA INCOMPTA P.W. Michael, Telopea 62: 181. 1995. **TYPE**: **Australia**. Victoria. Bright-Tawonga Rd. 9.7 km ESE of Bright, ca. 3.2 km E of Tawonga-Harrietville road fork, 25 Mar 1964, *R.V. Smith 64/64* (holotype: MEL; isotype: NSW).

Verbena bonariensis var. *brevibracteata* Kuntze, Rev. Gen. Pl. 3: 254. 1898. *Verbena litoralis* var. *brevibracteata* (Kuntze) O'Leary, Ann. Missouri Bot. Gard. 94: 598. 2007. **LECTOTYPE** (O'Leary 2006, p. 494): **Brazil**. Prov. Tucumán. Sierra de la Cuesta del Garabatal, 30 Jan 1874, *P.G. Lorentz 853* with Hieronymus (NY digital image!; isolectotypes: CORD, SI).

The NY lectotype of *Verbena bonariensis* var. *brevibracteata* clearly shows broadly clasping leaf bases characteristic of *V. bonariensis* and *V. incompta*, rather than, in the concept here, the basally attenuate to short-petiolate bases of *V. brasiliensis* or *V. litoralis*. O'Leary (2006) and O'Leary et al. (2007) studied the isolectotypes at CORD and SI—the illustration of var. *brevibracteata* by O'Leary et al. shows subclasping leaf bases, and their description of var. *brevibracteata* notes leaf bases "subamplexicaul to at times slightly auriculate." In the concept here, however, plants with clasping leaf bases are identified as *V. bonariensis* and *V. incompta*. Var. *brevibracteata* was described by O'Leary et al. as eglandular and is placed here as a synonym of *V. incompta*.

Plants annual or short-lived perennial, taprooted or with ligneous fibrous roots. **Stems** erect, 100–200 cm, scabrous to hispid or hispid-hirsute, eglandular. **Leaves** persistent, ovate to ovate-lanceolate, oblong-elliptic, or obovate, basally subclasping and subcordate, midstem blades (3–)5–10 cm x 10–35 mm, veins impressed adaxially, hispid-hirsute on both surfaces or strigose-hirsute adaxially, margins coarsely serrate; petioles absent. **Spikes** in 3s, forming compound cymes, the central mostly sessile on peduncles 0(–3) mm, inflorescence aspect corymbiform, comprising relatively compact and distinct clusters and subclusters, central and laterals dense and thick in fruit, (6–)10–40(–55) mm x 4–6 mm; floral bracts ovate to lanceolate or narrowly lanceolate, keeled, 3–4 mm, slightly longer than the calyces or equal, margins ciliate. **Calyces** 2.5–3.5 mm, strigose to strigose-hirsute, eglandular, lobes connivent. **Corollas** purple to red-purple, violet, or white, tubes 2.5–4 mm, limbs 3.5–5.5 mm in diam. **Nutlets** 1–1.2 (–1.4) mm, commissural faces extending to very tip of nutlets, densely bullate.

Flowering May–Jul(–Sep). Seasonally wet places, creek sides, mesic disturbed woods, fields, clearing, swales, ditches, borrow pits, disturbed sites; 5–100 m; introduced in Ont., Que.; Ala., Ariz., Ark., Calif., Fla., Ga., Ill., La., Mass., Miss., N.J., N.Y., N.C., Okla., Oreg., S.C., Tenn., Tex., Va.; native to South America; introduced also in Central America, Europe, Asia, Africa, Pacific Islands (Fiji, New Zealand, Norfolk Island, Papua New Guinea), Australia.

Distinction between *Verbena brasiliensis* and *V. litoralis*

The distinction between *Verbena brasiliensis* and *V. litoralis* is problematic, judging from recent literature, although the problem does not exist in North America. Both names have been used for plants identified at specific rank, and infraspecific variants have been named in each. *Verbena brasiliensis* has been treated as a variety of *V. litoralis* by Munir (2002) and O'Leary et al. (2007) because of the existence of putative intermediates. Some plants identified here as *V. incompta* were included by O'Leary et al. within their concept of *V. litoralis* (as var. *brevibracteata* = *V. brasiliensis*). The present commentary perhaps does not settle the matter but hopefully adds useful perspective.

Munir (2002, p. 75) observed that he "found no character(s) to maintain *V.*[*erbena*] *litoralis* and *V. brasiliensis* as distinct species. Both are extremely variable in the shape and size of the leaves, length and diameter of the spikes, [and] congestion and laxity of flowers particularly in the lower part of their spikes. For each character there seem to be intermediates between the two taxa although there are some extreme cases where these taxa look different from each other in the size and shape of their leaves and spikes. Due to the presence of these intermediates, it has been difficult to draw a line between the two." On the other hand (and seemingly in contrast), Munir noted (p. 75) that "var.

brasiliensis may readily be identified …" by the contrasts below, and he mapped var. *litoralis* and var. *brasiliensis* as almost completely sympatric in Australian distribution, without indication of intermediates.

Munir (2002)

1. Spikes dense at first, later elongating with flowers remote in the lower half of the rachis, usually 3–8(–12) cm long; stems 4-angled but not sharply so; hairs on rachis, bracts, and calyx minute and closely appressed; floral bracts ovate to ovate-lanceolate, subequal or somewhat shorter than the calyx; leaf blades attenuate toward the base, margins serrate-dentate, with both blunt (rounded) and sharp teeth ..... **Verbena litoralis** var. **litoralis**

1. Spikes dense, not elongating, (1–)2–6(–8, rarely –15), with closely congested flowers; stems very sharply angled; hairs on rachis, bracts, and calyx spreading; floral bracts narrowly lanceolate, equalling the calyx or slightly longer; leaf blades cuneate toward the base, sometimes half-clasping, margins serrate-dentate ..... **Verbena litoralis** var. **brasiliensis**

O'Leary et al. (2007) followed essentially the concept of Munir (2000) in distinguishing *Verbena litoralis* and *V. brasiliensis* and also in treating them as varieties of a single species (but using "var. *brevibracteata*" as the name for the "brasiliensis" entity). They noted that *V. litoralis* is variable throughout its range but did not comment on biological interaction between the two varieties or on putative intermediacy and intergradation. Typical *V. litoralis* has a considerably wider South American distribution than var. *brevibracteata*, but O'Leary et al. viewed the two entities as sympatric (as interpreted through specimen citations) in parts of Brazil and Paraguay and in all of Argentina except southernmost provinces (Chubut and Santa Cruz).

O'Leary et al. (2007)

1. Leaves basally attenuate-cuneate to subpetiolate, the basal up to 5 cm long and 2.5 cm wide; inflorescence puberulent, eglandular; flowers remote in the basal part of the rachis; floral bracts ovate; corolla tubes 3–4 mm ..... **Verbena litoralis** var. **litoralis**

1. Leaves basally subamplexicaul, exceptionally [or "at times"] auriculate, the basal up to 10 cm long; inflorescence pilose or sometimes strigose; bracts and calyces sometimes with a few glandular hairs; flowers densely imbricate along the rachis; floral bracts narrowly ovate; corolla tubes ca. 4.5 mm ..... **Verbena litoralis** var. **brevibracteata**

Using a contrast in inflorescence architecture, O'Leary et al. (2007, couplet 13a/b, p. 579) distinguished *Verbena bonariensis* (including two varieties) from *V. litoralis* (including var. *brevibracteata* = *V. brasiliensis* and var. *litoralis*).

13a. Florescencias reunidas en paracladios multímeros aglomerados en torno a la florescencia principal, nunca superándola ..... **Verbena bonariensis**

13b. Florescencias reunidas en paracladios trímeros no aglomerados en torno a la florescencia principal, superándola ..... **Verbena litoralis**

An earlier study of inflorescence architecture in *Verbena* (Martínez et al. 1996) underlies the concepts and descriptions used by O'Leary et al. The contrast (as in 13a/b) is freely interpreted here in less technical terms ("paracladia" are branches similar in structure to the florescence of the main axis—in *Verbena* essentially spikes mostly in 3's or groups of spikes in 3's) and somewhat expanded. The difference essentially reflects the degree of foreshortening of peduncles and spikes.

a. Central spikes mostly sessile, with short-pedunculate lateral spikes relatively short in fruit and closely clustered, the whole inflorescence with a corymbiform aspect, comprising relatively compact and distinct clusters and subclusters ..... **Verbena bonariensis**

a. Central spikes relatively long-pedunculate, with long-pedunculate lateral spikes relatively elongate in fruit and loosely associated, the whole inflorescence loosely paniculiform aspect, comprising well-separated spikes ..... **Verbena litoralis**

This contrast is appropriate as a distinction between *V. bonariensis* and *Verbena litoralis*, but as the taxa are understood here, the inflorescence of *V. brasiliensis* is essentially identical to that of *V. bonariensis* and *V. incompta*, not like that of *V. litoralis*. Inflorescence architecture is a conspicuous difference between *V. brasiliensis* and *V. litoralis*, but other features also separate them—*V. brasiliensis* has taller, more hispid, and thicker stems, thicker leaves with veins impressed adaxially, and larger floral bracts, calyces, and corollas.

VERBENA BRASILIENSIS Vell., Fl. Flumin., 17. 1829. *Verbena litoralis* var. *brasiliensis* (Vell.) Briq. [nom. illeg.], Ann. Conserv. Jard. Bot. Genève 7-8: 292. 1904. **TYPE**: **Brazil**. Rio de Janeiro, without data. **LECTOTYPE** (Verdcourt 1992, p. 9): Vellozo, Fl. Flumin., Icon. 1: plate 40. 1831 ("1827").

In proposing the nomenclatural combination, Briquet (1904) intended this variety to characterize the typical expression of the species and explicitly included "*V. litoralis* Kunth, l.c., sensu stricto" as a synonym. O'Leary et al. (2007) correctly that noted that Briquet's combination was invalid and attributed its authorship to Munir (2002), but Munir simply cited the Briquet reference and did not make the combination.

Verbena quadrangularis Vell., Fl. Flumin., 16. 1829 ("1825"). **TYPE**: **Brazil**. Rio de Janeiro, without data. **LECTOTYPE** (Verdcourt 1992, p. 10): Vellozo, Fl. Flumin., Icon. 1: plate 39. 1831 ("1827").

Verbena hansenii Greene, Pittonia 3: 308. 1898. **TYPE**: **USA**. California. Amador Co.: Clinton, foothills of the Sierra Nevada, 1889, *G. Hansen s.n.* (holotype: ND-G; isotypes: K, MO-as cited by Perry 1933). See comments by O'Leary et al. on the disparity between collection data in the protologue and on the presumed ND-G holotype. Identified by O'Leary et al. as the "brasiliensis" expression. A topotype identified by the collector as *Verbena hansenii* is *V. brasiliensis*: California. Amador Co.: Clinton, 2000 ft, 6 Oct 1896, *G. Hansen 2025* (MO!).

Verbena litoralis forma *angustifolia* Chod., Bull. Herb. Boissier, ser. 2(9): 818. 1902. **TYPE**: **Paraguay**. Tucangua, Feb 1897, *E. Hassler 3853* (holotype: BM; isotypes: G, NY-2 sheets digital images!). Leaves are narrow but coarsely serrate; fruiting spikes dense except at the base, where looser and fruits deciduous, central spikes nearly sessile. Identified as *V. brasiliensis* by Moldenke, as *V. litoralis* sensu stricto by O'Leary et al.

Verbena approximata Briq., Ann. Conserv. Jard. Bot. Geneve 7-8: 292. 1904. **TYPE**: **Paraguay**. Grand Chaco, en face de l'Assomption, 1875, *B. Balansa 1027c* (holotype: P; isotypes: G, P, SI). Not seen. Identified by O'Leary et al. (and earlier by Troncoso) as *V. litoralis*. A paratype clearly is *V. brasiliensis*: **Paraguay**. Sierra de Maracayú, vicine Igatimí, Oct, *E. Hassler 4887* (G-Delessert, photo-MO!).

Verbena brasiliensis var. *subglabrata* Moldenke, Phytologia 3: 278. 1950. **TYPE**: **Chile**. [Prov. Colchagua], San Fernando, 7 Feb 1930, *E. Barros V. 8050* (holotype: NY digital image!). The NY sheet bears only a leafless portion of inflorescence, which has dense, short, sessile to subsessile central and lateral spikes. It is apparently out of range for *V. bonariensis* and *V. incompta*.

Verbena chacensis Moldenke, Phytologia 5: 228. 1955. **TYPE**: **Paraguay**. Gran Chaco, Loma Clavel, Nov 1903, *E. Hassler 2459* (holotype: UC, fragment TEX!; isotypes; P, SI). Identified by Munir and O'Leary et al. as the "brasiliensis" expression.

Verbena litoralis Kunth var. *congesta* Moldenke, Phytologia 20: 80. 1970. **TYPE**: **Mexico**. Sinaloa. Mpio. Badiraguato, Sierra Surutato, along a small stream 0.5 of a mile N of Los Ornos, slope with *Quercus urbani*, *Quercus epileuca*, *Pinus humholzii*, *Pinus ayacahuite*, and *Arbutus xalapensis*, 1 Nov 1969, *D.E. Breedlove & F.S. Kawahara 16735* (holotype: TEX!; isotype: SI). Identified by O'Leary et al. as the "brasiliensis" expression, tentatively confirmed here.

Plants annual or short-lived perennial, taprooted or with ligneous fibrous roots. **Stems** erect, 70–150(–250) cm, sparsely to moderately hispid. **Leaves** persistent, lanceolate to rhombic-lanceolate

or lanceolate-elliptic, cuneate-attenuate at base, midstem blades (2–)5–8 cm x 10–25 mm, veins impressed adaxially, adaxially strigose-hirsute, abaxially hirsute mostly along the veins, margins serrate; petioles absent. **Spikes** in 3s, forming compound cymes, the central sessile to subsessile on peduncles 0–5(–10) mm, inflorescence aspect corymbiform, comprising relatively compact and distinct clusters and subclusters, central and laterals dense and thick in fruit, (5–)10–30(–50) mm x 3–5 mm; floral bracts narrowly lanceolate, 2.5–4 mm, about equal or longer than the calyces. **Calyces** (2.5–)3–3.5 mm, loosely strigose to hirsute-strigose, eglandular, lobes connivent. **Corollas** usually purple to blue or blue-violet, tubes 3–4 mm, limbs (2–)2.5–3.5 mm in diam. **Nutlets** 1–1.4 mm, commissural faces extending to very tip of nutlets, densely papillate. $2n = 28$.

Flowering (Apr–)May–Sep. Cut-over pine and oak-pine woods, pine flatwoods, river bottoms, river and canal banks, marsh edges, creek bottoms, hillside seeps, ditches, depressions, shell banks, clearings, vacant lots, fields and pastures, roadsides, fence rows, disturbed sites; 10–100(–200) m; introduced in Ala., Ark., Calif., Fla., Ga., Ky., La., Miss., Mo., N.C., Okla., Oreg., S.C., Tenn., Tex. Va.; native to South America; introduced also in Mexico (Michoacan, Nuevo León, Sinaloa), Europe, Africa (South Africa), Madagascar, Australia.

Suksdorf 1980 was cited by Moldenke (1962b) as *Verbena brasiliensis* and its identity is confirmed here. **Oregon**. [Multnomah Co.]: Linnton near Portland, 11 Aug 1914, *Suksdorf 1980* (WS digital image!).

If *Verbena brasiliensis* is treated at varietal rank within *V. litoralis*, the earliest available name at that rank is *V. brasiliensis* var. *subglabrata*, which would have to be transferred to *V. litoralis*. The name used by Munir (2002), *V. litoralis* var. *brasiliensis*, is illegitimate. The clasping leaves and eglandular vestiture of the type of *V. litoralis* var. *brevibracteata* place this taxon as a synonym of *V. incompta*, the small-flowered, eglandular expression of *V. bonariensis* sensu lato (see comments above). In the present perspective, *V. brasiliensis* and *V. litoralis* are distinct species.

Verbena brasiliensis and *V. quadrangularis* are from the same publication by Velloso—Yeo (1990) considered them to synonymous, noting that Velloso described *V. brasiliensis* as differing only in having a 4-lobed corolla (vs. 5-lobed in *V. quadrangularis*), one lobe being larger than the others and crenate, and apparently in producing two nutlets per fruit instead of four. Michael (1997) noted that such corolla morphology occurs in sterile plants that apparently are hybrid between *V. litoralis* and fertile *V. brasiliensis*-like plants. He identified the latter as *V. quadrangularis*, the sterile hybrids as as *V.* ×*brasiliensis*. O'Leary et al. (2007) studied "numerous specimens" of *V. brasiliensis* (as "*V. litoralis* var. *brevibracteata*") and found none with aberrant features. Since the putative hybrid shows no other morphological features suggestive of hybridization with *V. litoralis*, *V. brasiliensis* is maintained here as the name of this widespread adventive.

Status of *Verbena sphaerocarpa*.

Verbena sphaerocarpa was treated by O'Leary et al (2007) as a synonym of *V. litoralis*. These plants, however, have the habit, inflorescence, and stem and leaf vestiture of *V. brasiliensis*, but the leaves are oblong-elliptic, entire to subentire, and petiolate, and as noted by Perry (p. 256), "the schizocarp is fully as broad as or even broader than long, an unusual trait not found elsewhere in the North American species of *Verbena*." Calyces of *V. sphaerocarpa* are 2–2.3 mm (vs. (2.5–)3–3.5 mm in *V. brasiliensis*) and floral bracts are ovate-triangular and 1/2–2/3 the calyx length (vs. narrowly lanceolate and equal or longer than the calyx). Limited evidence suggests these plants are justifiably recognized as distinct.

Verbena sphaerocarpa Perry, Ann. Missouri Bot. Gard. 20: 256. 1933. **Type**: **Mexico**. Colima. Socorro Island, Mar-Jun 1897, *A.W. Anthony 380* (holotype: MO digital image!; isotypes: GH, US digital image!).

Additional collections examined: Socorro Island: Evermann Peak, slopes of volcanic cone within 50 m of summit, 1000+ m, 21 Mar 1967, *Felger 15758* (ARIZ); south slope of Mt. Evermann, 600 m, 20 Mar 1967, *Felger 15822* (ARIZ); Grayson's Cove, 4 May 1925, *Mason 1612* (MO!).

VERBENA LITORALIS Kunth in Humboldt et al., Nov. Gen. Sp. 2(qto.): 276, plate 137. 1818. **LECTOTYPE** (Macbride 1960, p. 624): [**Peru**]. Trujillo, *A. Bonpland s.n.* (P; isotype: SI). Plate 137 nicely illustrates the open inflorescence of slender, long-pedunculate spikes with fruits becoming remote proximally as they mature.

In comments on *Verbena bonariensis*, Hooker (Bot. Misc.1: 166. 1829) said "The *Verbena littoralis* of Humboldt seems to be a variety of this with shorter spikes than usual." This statement sometimes has been taken as validation of the combination "*V. bonariensis* var. *litoralis* (Kunth) Hook.," but it was inadequate for validation since the publishing author must definitely associate the epithet with the name of the genus (ICBN Art. 33.1).

Verbena caracasana Kunth, Nov. Gen. Sp. 2(qto.): 275. 1818. *Verbena litoralis* var. *caracasana* (Kunth) Briq. [nom. illeg.], Ann. Conserv. Jard. Bot. Genève 7-8: 292. 1904. **LECTOTYPE** (O'Leary 2006, p. 494): **Venezuela**. "Rarissime in sylvaticis prope Caracas," *F.W. Humboldt and A. Bonpland 658* (P fiche!; isolectotypes: B photo MO!, SI).

Briquet explicitly intended the combination "var. *caracasana*" as a replacement name for *V. litoralis* var. *leptostachya* Schauer.

Verbena affinis Mart. & Gal., Bull. Acad. Roy. Sci. Bruxelles 11: 322. 1844. **TYPE**: **Mexico**. Michoacan. Morelia, 1956 m, 1840, *H.G. Galeotti 781* (holotype: BR photo-TEX!; isotype: BR, K photo-MO!). Identified as *V. litoralis sensu stricto* by O'Leary et al. (2007).

Verbena longifolia Mart. & Gal., Bull. Acad. Roy. Sci. Bruxelles 11: 323. 1844. **TYPE**: **México**. Michoacan. [Mpio. Ario], dans les champs d'Ario [de Rosales], 4000 ft, Aout 1840, *H. Galeotti 791* (holotype: BR, photos at LL!, also F, NY, SI, and Z, fide Moldenke 1964b). The protologue noted glabrous stems and glabrous, filiform, elongate spikes in a panicle, specifically comparing it to *V. urticifolia*. O'Leary et al. (2010) place *V. longifolia* as a synonym of *V. carolina* L.

Verbena litoralis var. *leptostachya* Schauer in A. D.C., Prodr. 11: 542. 1847. **LECTOTYPE** (Munir 2002, p. 65): **Mexico**. [Veracruz]. Ad Jalapam et Papantlam, *C.J.W. Schiede 1168* (HAL). Placed as a synonym of *V. litoralis* by O'Leary et al (2007).

Verbena litoralis var. *pycnostachya* Schauer in A. D.C., Prodr. 11: 542. 1847 [nom. illeg.]. Schauer cited *V. litoralis* in synonymy, as well as *V. brasiliensis*.

Verbena litoralis var. *glabrior* Bentham, Bot. Voy. Sulphur, 153. 1846. **TYPE**: **Peru**. [Prov. Paita]: "Peita" [Paita], no other data (holotype: K?). Not seen. Protologue: "706. VERBENA *littoralis*, var.? glabrior, foliis hinc inde trifidis grosse et obtusiuscule inciso-dentatis. An species propria? Folia *V. menthaefoliae*, Benth. Pl. Hartw. p. 21. sed flores parvi V. littoralis.—Peita."

Verbena nudiflora Nutt. ex Turcz., Bull. Soc. Imp. Naturalistes Moscou 36(2): 195. 1863. **TYPE**: **Sandwich Isles** [Hawaii]. "Wahoo" [Oahu], 1835, *T. Nuttall s.n.* (holotype: BM; isotype: PH fide Moldenke 1964b, p. 58). Photos labeled as the BM type of "*Verbena nudiflora*" have been distributed (MO!, SMU!), but the plant pictured is *Allexis cauliflora* Pierre (Violaceae) from tropical Africa, evidently from a labeling error. Munir (2002) cited collections by Funk (*54, 325*) and Galeotti (*359*)—these are paratypes. See further notes by O'Leary (2006).

Verbena paucifolia Turcz., Bull. Soc. Imp. Naturalistes Moscou 36(2): 196. 1863 (non Mart. & Gal. 1844). **TYPE**: **Mexico**. Oaxaca. Without other data, *Botteri 659* (holotype: P?). Attribution of this collection to "*Botteri s.n.*, Texas" by O'Leary et al. (2007) was incorrect. Placed as a synonym of *V. litoralis* fide O'Leary et al.

Verbena integrifolia Sessé & Mociño [nom. illeg.?], Naturaleza (Mexico City), ser. 2, 1: app. 6. 1887 (non Michx. ex Walp., Repert. Bot. Syst. 4: 18. 1845, nom. illeg., in syn.). **TYPE**: **Mexico**.

[Querétaro]. "Habitat in Queretari circuitibus." McVaugh (2000) noted that no corresponding specimen is found in the Sessé & Mociño herbarium. According to Moldenke (1964c, p. 373), "The *V. integrifolia* of Michaux is a synonym of *V. simplex* and was published by Walpers … in synonymy only, so therefore does not invalidate the use of the same epithet by Sessé & Mociño."

Verbena litoralis var. *albiflora* Moldenke, Phytologia 1: 432. 1940. **TYPE**: **Mexico**. Michoacan. Distr. Coalcoman, Coalcoman, llano, 1000 m, 20 Jul 1939, *G.B. Hinton 13965* (holotype: LA photo-LL!; isotype: US digital image!).

Verbena gentryi Moldenke, Phytologia 2: 27. 1941. **TYPE**: **Mexico**. Sinaloa. Sierra Monterey, Quebrada de Platano, moist canyon bottom, short tree forest, 1500 ft, 13 Mar 1940. *H.S. Gentry 5923* (holotype: NY digital image!; isotypes: F digital image!, MICH digital image!). O'Leary et al. (2010) place *V. gentryi* as a synonym of *V. carolina* L.

Verbena longifolia forma *albiflora* Moldenke, Phytologia 7: 430. 1961. **TYPE**: **México**. Oaxaca. Vicinity of Cerro Zempoaltepetl, E slopes near Patio de Arena ca. 5 km E of summit, cloud forest, along moist claybanks drainage area from cornfield cleared among *Persea*, ca. 2900 m, 7 Aug 1950, *B. Hallberg 813* (holotype: MICH digital image!; isotypes: DS, LL! digital image!, US digital image!). O'Leary et al. (2010) place this as a synonym of *V. carolina* L.

Verbena longifolia var. *pubescens* Moldenke, Phytologia 13: 307. 1966. **TYPE**: **México**. Oaxaca. 19 km SW of Sola de Vega along road to Puerto Escondido, steep slope with *Quercus* and *Pinus*, 7000 ft, 30 Aug 1965, *D.E. Breedlove 12292* (holotype: LL! digital image!; isotypes: DS, MICH digital image!). O'Leary et al. (2010) place this as a synonym of *V. carolina* L.

Verbena integrifolia Sessé & Mociño forma *albiflora* Moldenke, Phytologia 16: 95. 1968. **TYPE**: **Mexico**. Michoacan. 18 mi E of Zamora, 20 Jun 1967, *A.R. Moldenke 1750* (holotype: TEX! digital image!; isotypes: TEX!, SI).

Verbena minutiflora Briq. ex Moldenke var. *peruviana* Moldenke, Phytologia 50: 14. 1981. **TYPE**: **Peru**. Prov. Cajamarca. Pampa de la Culebra (Cajamarca-La Encañada), terreno cultivado, 2900 m, 18 May 1976, *A.J. Sagastegui et al. 8385* (holotype: TEX! digital image!; isotypes: MO! digital image!, SI). Plants depauperate and deformed, spikes short and atypical. Identified by O'Leary et al. (2007) as *V. montevidensis*.

Verbena litoralis var. *portoricensis* Moldenke, Phytologia 50: 310. 1982. **TYPE**: **Puerto Rico**. Cayey. On Panoramic Highway, south of Cayey, 640 m, 14 Mar 1979, *A.H. Liogier 28417* (holotype: NY digital image!). Identified by Munir and O'Leary et al. as *V. litoralis* sensu stricto, tentatively corroborated here, although the large cauline leaves are unusual.

Plants annual or short-lived perennial, taprooted or fibrous rooted. **Stems** erect, 50–100 cm, sparsely strigose to hirsute-strigose or hispid-hirsute, eglandular. **Leaves** persistent, lanceolate to elliptic-lanceolate or oblanceolate, midstem blades 2–5(–11) cm x 1–1.5 cm, veins not impressed adaxially, hirsute-strigose adaxially, glabrate to sparsely or moderately strigose-hirsute abaxially, eglandular, margins coarsely serrate on distal 1/2–2/3, not revolute; petioles absent or 1–5 mm. **Spikes** in 3s, forming obscure compound cymes, central pedunculate on peduncles 10–40 mm, inflorescence aspect loosely paniculiform, comprising well-separated spikes, central and laterals, 3–15 cm x 2–3 mm, fruits becoming remote on at least the proximal 1/4–1/2; floral bracts ovate-lanceolate, 1–1.5 mm, shorter than the calyces, margins ciliate, adaxial surface glabrous to sparsely strigose. **Calyces** 1.8–2.2 mm, sparsely and loosely strigillose to hispidulous-strigose, eglandular, lobes connivent. **Corollas** white to blue, purplish, or pale violet, tubes 2–2.5(–3) mm, 0–0.5(–1) mm longer than the calyx, limbs 1.5–2 mm in diam. **Nutlets** 1.1–1.5 mm, commissural faces extending to very tip of nutlets, bullate, rarely bare. $2n = 28$.

Flowering Feb–Oct. Openings, disturbed sites; 600–2700 m; not known in the USA; native to northern and western South America (northwestern Argentina, Bolivia, Chile, Columbia, Ecuador, Peru, Venezuela), northward through Central America and Mexico (Aguascalientes, Distrito Federal, Hidalgo, Jalisco, Edo. Mexico, Michoacan, Nuevo León, Oaxaca, Sinaloa, Tabasco, Tamaulipas,

Veracruz); introduced in West Indies, Africa, Indian Ocean Islands (Reunion, Mauritius), Pacific Islands, Australia.

Records previously identified as *Verbena litoralis* from Arkansas, Florida, Oregon, and Texas are identified here as *V. montevidensis* (see below). *Verbena litoralis* also has been cited from other states in the USA, based on concepts that included *V. brasiliensis*. Collections identified as *V. litoralis* from eastern Argentina and Uruguay probably are *V. montevidensis*, as interpreted here.

Plants of *Verbena litoralis* sensu lato in southwestern Mexico (Querétaro, Michoacan, Jalisco, Nayarit, Colima, Sinaloa) commonly have glabrous to glabrate, narrowly oblong narrowly lanceolate-oblong leaves with entire to subentire margins. Similar forms of *V. litoralis* also appear sporadically elsewhere. These have sometimes been identified as *V. integrifolia* Sesse & Moc. and at least at one locality are reported to be hexaploid ($2n = 42$; Lewis & Oliver 1961). Other names applied to this expression are *V. affinis*, *V. litoralis* var. *albiflora*, and *Verbena integrifolia* forma *albiflora*.

Verbena longifolia is included here in synonymy of *V. litoralis*. Perry (1933, p. 272) noted that the latter is "A rather singular species combining the foliar characters of *V. litoralis* with the inflorescence characters of *V. carolina*." Nash and Nee (1984) distinguished the two taxa by the following contrasts (translated from Spanish).

1 Leaf margins serrate above the middle, floral bracts almost two-thirds as long as the calyces, nutlets with muriculate commissural faces ..... **Verbena litoralis**
1 Leaf margins serrate below the middle, floral bracts about as long as the calyces, nutlets with smooth commissural faces ..... **Verbena longifolia**

A review in the present study of several hundred collections of *V. litoralis* and *V. longifolia*-like specimens from MO and TEX-LL shows that there is no unarbitrary distinction. Almost all plants of *V. litoralis* have consistently cymose branching but rarely (Guanajuato, Guerrero, Querétaro) the branches are not opposite and the inflorescence then is similar to the paniculate structure in North American groups. Spikes of some plants have fruits that become remote over the whole length. These variants are similar in every other detail to *V. litoralis* in its common expression throughout Mexico.

Moldenke (1964b) cited collections of *Verbena longifolia* from over a wide range—Coahuila, Jalisco, Michoacan, Morelos, Nayarit, Oaxaca, Puebla, Sinaloa, Sonora, Veracruz. Perry (1933) and Nash & Nee (1984) cited only from Morelos, Oaxaca, Puebla, and Veracruz.

***Verbena montevidensis* in the USA**

Verbena montevidensis has been collected repeatedly in southeastern Arkansas since the mid 1930's—it also probably has been established in Louisiana at least that long—and it also is known from other localities mostly in the southeastern USA. *Verbena montevidensis* is most closely similar to *V. litoralis*, differing from it in its more highly branched inflorescences with shorter and more numerous spikes, central spikes on relatively shorter peduncles, inflorescence more densely corymbiform in aspect, and stems more slender. Leaves of *V. montevidensis* often are deciduous by flowering and vestiture is reduced, with stems usually glabrous to glabrate or sparsely hirsutulous-strigose. O'Leary et al. (2007) distinguished *V. montevidensis* (from *V. litoralis*) by its filiform stems and peduncles, stem height up to 1 meter, and fruiting spikes up to 6 cm long (vs. aspect not gracile, stem height up to 3 m, and fruiting spikes up to 18 cm). In South America, *V. montevidensis* generally is a species of eastern regions, while *V. litoralis* is more montane and mostly in the west.

VERBENA MONTEVIDENSIS Spreng., Syst. Veg. 2 (ed. 16): 747. 1825. **TYPE**: **Uruguay**. Monte Video, *F. Sellow s.n.* (holotype: B[destroyed], photo-LL! photo-MO!).

Verbena parviflora Larranaga, Escritos 2: 9. 1922 (non Ruiz & Pavón 1845). **TYPE**: **Uruguay**. Not seen. Probably *V. montevidensis*, based on provenance and the allusion to small flowers.

Verbena cordobensis Briq., Annuaire Conserv. Jard. Bot. Genève 10: 100. 1907. **TYPE**: **Argentina**. Estancia Germanica pr. Cordoba, Jun-Dec 1874, *P.G. Lorentz 131* (holotype: G?; isotype: M photo-MO!).

Verbena minutiflora Briq. ex Moldenke, Phytologia 7: 84. 1959. **TYPE**: **Uruguay**. Montevideo, *Captain P. King 78* (holotype: G, photo-F!). "This species is related to *V. montevidensis* Spreng., but is easily distinguished in any series of specimens" (from the protologue). Placed as a synonym of *V. montevidensis* fide O'Leary et al. (2007), tentatively corroborated here.

Plants annual, taprooted or fibrous rooted. **Stems** erect, 40–80 cm, glabrous to glabrate or sparsely hirsutulous-strigose. **Leaves** mostly deciduous by flowering, elliptic to narrowly elliptic or lanceolate, basally acute-cuneate, midstem blades 2–4(–5) cm x 4–8 mm, veins impressed adaxially, margins subentire to inconspicuously dentate to shallowly serrate on the distal 1/3–1/2, glabrate or sometimes hirsutulous abaxially along the veins; petioles absent. **Spikes** in 3s, forming compound cymes, central short-pedunculate on peduncles (0–)2–10(–20) mm, inflorescence aspect loosely corymbiform, comprising loosely but distinctly associated spikes, central and laterals (5–)10–35(–50) mm x 2–3 mm in fruit, fruits becoming remote on the proximal 1/4–1/3; floral bracts ovate, 1–2.2 mm, shorter than the calyces. **Calyces** 2–2.5 mm, strigillose, eglandular, lobes connivent. **Corollas** purple to light lavender or white, tubes 2.5–5 mm, 0–0.5 mm longer than the calyx, limbs 1–1.6 mm in diam. **Nutlets** 1.2–1.5 mm, commissural faces extending to very tip of nutlets, minutely bullate-papillate. $2n = 21$.

Flowering Jun–Jul(–Sep). Creek and lake edges, river bottoms, ditches, low woods, fields, roadsides; 10–100 m; introduced in Ala., Ark., Fla., Ga., La., Oreg. (apparently waifs), Tex.; native to South America (Argentina, Brazil, Paraguay, Uruguay).

Representative collections examined. **Alabama**. Montgomery Co.: near Montgomery on I-85, ca. 1 mi E of intersection with US 180, 8 Jul 1969, *Thomas 2300* (BRIT). **Arkansas**. Ashley Co.: Portland, margins of Wells Lake, open ground, 16 Oct 1937, *Demaree 44270* (MO); Portland, around Wells Lake, 115 ft, 16 Oct 1938, *Demaree 16511* (MO, SMU), *17623* (SMU), and *17624* (MO); Hamburg, low areas, 170 ft, 26 Aug 1942, *Demaree 23893* (SMU); Mist, sandy areas, 190 ft, 8 May 1943, *Demaree 24403* (SMU); P.O. Parkdale, Coastal Plain, waste areas, 112 ft, 12 Sep 1973, *Demaree 67598* (MO); wet area and small pond ca. 1 mi W of Sardis Baptist Church between Fountain Hill and Boydell, 12 Jun 1985, *Thomas 92653* (MO); ca. 6 mi W of US 165 and Boydell, field on top of first hill W of flat delta, 20 Jun 1986, *Thomas 97103* (VDB), *Thomas 97104* (NLU). Bradley Co.: Banks, creek banks, 200 ft, 4 Jul 1939, *Demaree 19543* (SMU). Calhoun Co.: Calion, Ouachita River bottoms, road fill, 27 May 1954, *Holberg 475* (SMU). Chicot Co.: Wilmot, valley land, 19 Jul 1946, *Demaree 25674* (SMU). Drew Co.: Monticello, low ridges, 250 ft, 14 Sep 1943, *Demaree 34649* (SMU) and 24649 (VDB). **Florida**. Dade Co.: The Frog Pond, edge of farm field, just W of C-111 Canal, ca. 1.2 mi N of SR 9336, 8 Nov 1997, *Bradley 1191* (FTG digital image!). Walton Co.: savanna along Rte. 20, ca. 6 mi W of Freeport, 3 May 1982, *Correll 53910* (FTG digital image!). Unspecified Co.: south Florida, roadside marl, 29 Jul 1969, *Byrd s.n.* (FTG-2 sheets digital images!). **Louisiana**. Allen Par.: beside US 190 at La 383 E of Kinder, 14 Dec 1982, *Thomas 82761* (LL). Avoyelles Par.: 1/2 mi W of Evergreen, sandy soil of newly planted cane field, Pierce-Kavanaugh refinery, 21 Apr 1957, *Ewan 19083* (LL); Bunkie, May 1931, *Small s.n.* (LL-3 sheets). Caldwell Par.: beside RR tracks and US 165 N of Riverton and S of La. 847, 10 Jul 1987, *Thomas 100,744* (BRIT). Catahoula Par.: 1.7 mi N of Sicily Island, roadside, 19 Sep 1956, *Shinners 24687* (SMU). Bienville Par.: roadbank of I-20 ca. 0.6 mi W of La. 154 (Gibsland exit), W of Arcadia, 11 Jun 1987, *Thomas 100,092* (MO). Evangeline Par.: 7.3 mi N of Turkey Creek, road fill, 5 Oct 1956, *Shinners 24951* (SMU). Franklin Par.: 4.7 mi NNE of Winnsboro, roadside ditch, 19 Sep 1956,

Shinners 24668 (SMU); 6 mi NE of Gilbert, 0.5 mi S of intersection La. 4 and La. 128 on La. 572, cutover hardwoods, 6 May 1981, *Thomas 76152* (BRIT). Jefferson Par.: ca. 3.7 mi W of Lapalco Blvd. near Westwego, cleared recently disturbed area N of US 90, 15 Jun 1981, *Thomas 123,862* (MO). Lincoln Par.: beside I-20 at Rest Area E of La. 145 and Choudrant exit, W of Calhoun, 11 Oct 1986, *Thomas 98774* (MO). Natchitoches Par.: Kisatchie Natl. Forest, moist area beside La. 118 W of La. 117 and E of Little Kisatchie Bayou E of Mink, 9 Jul 1988, *Thomas 105,666* (MO). Ouachita Par.: waste area beside la 553 at Commercial Solvents Storage Area SW of Sterlington, 19 Jul 1983, *Thomas 84556* (LL). Richland Par.: 8.5 mi W of Rayville, silty ditch bank, 27 Jul 1950, *Shinners 12618* (SMU). Sabine Par.: abundant along roadside of La. 473 along Bayou Toro, ca. 2.8 mi NE of Toro, pine-hardwood forest, 24 Jun 1979, *Allen 9131* (BRIT, VDB). St. John the Baptist Par.: W banks of the Mississippi River, fallow fields along River Road (La 18) between Wallace and Johnston, 26 Jul 1981, *Pruski et al. 2133* (TEX). Union Par.: beside Bayou de Loutre and La. 33, S of Marion, 10 Jun 1983, *Thomas 84050* (BRIT). Washington Par.: just E of intersection near Miss. line W of Warnerton, along road at pasture feeding area, 14 Jun 1983, *Thomas 84169* (LL). **Oregon**. [Multnomah Co.]: Albina, Portland, 25 Oct 1900, *Suksdorf 2912* (WS digital image!) and *2913* (WS digital image!). **Texas**. Brazoria Co.: between Navarre Hillhouse Rd. and Stringer Rd., S of County Rd 91, near (S of) FM 518 and W of Old Chocolate Bayou Rd., 30 Apr 1985, *Cowan 5316* (TEX). Liberty Co.: W side of Cleveland, bottoms of East San Jacinto River, by hwy bridge, 13 Aug 1956, *Shinners 24414* (SMU). Limestone Co.: Fort Parker State Park, Hwy 14 and Park Rd 28, Jun 1993, disturbed area, *Singhurst et al. 1748* (BRIT). Newton Co.: 23 Jul 1939, *Tharp s.n.* (TEX). Orange Co.: 6 mi N of Orange, shallow roadside ditch bank, 17 May 1966, *Shinners 31381* (SMU).

Moldenke (1964b, p. 67) cited many of these collections as *Verbena litoralis* (e.g., *Demaree 16511*, *17624*, *19543*, *23893*, *24403*, *24649*, *25674*, *34649*). For *V. montevidensis* in North America, he cited (1964c, p. 161) only collections of Ewan from Louisiana (Avoyelles Par., Evangeline Par.), none from Mexico or the West Indies. Perry cited as *V. litoralis* an additional collection from Lousiana (Terrebonne Par., *Wurzlow s.n.*, NY), which probably is *V. montevidensis*; From California, she included *V. hansenі* as a synonym of *V. litoralis*, but that is identified here as *V. brasiliensis*; other attributions of *V. litoralis* to California also are based on *V. brasiliensis*. The collections from Oregon probably were of waifs, as the species has not subsequently been reported from there. Reports of *V. litoralis* from Georgia (Jones & Coile 1988) probably are based on *V. montevidensis*.

Verbena montevidensis is abundant and widespread in Louisiana. At NLU, I examined collections of the species from these parishes: Allen, Assumption, Beauregard, Bienville, Bossier, Calcasieu, Caldwell, Cameron, Concordia, East Baton Rouge, Evangeline, Franklin, Grant, Iberia, Jackson, Jefferson, LaFourche, LaSalle, Lincoln, Livingston, Madison, Morehouse, Natchitoches, Ouachita, Pointe Coupée, Rapides, Richland, Sabine, St. John the Baptist, St. Landry, St. Mary, Tangipahoa, Tensas, Terrebonne, Union, Webster, and West Carroll. It is likely that the species occurs at least in Mississippi and perhaps more commonly in Alabama and Florida than represented here.

I have seen only a single collection of *Verbena montevidensis* from Mexico: Baja California Sur. Santa Rita, Km 157 Carr. La Paz-Cd. Constitución, arroyo, matorral sarcocaule, 100 m, 11 Jun 1993, *Domínguez 1136* (ARIZ). *Verbena litoralis* is common in Central America, but I have encountered only two collections from there that can be identified as *V. montevidensis*: **Costa Rica**. Prov. San José. San José, open vacant lots, 1160 m, 18 Mar 1965, *Godfrey 67100* (MO). **Nicaragua**. Dept. Managua. Carr. a Las Nubes, a mano izquierdo en un cafetal, 11 Jul 1982, *Mendez R. 9* (MO). It is possible that they are variants of *V. litoralis* but plants of both collections have short spikes clustered on numerous distal branches forming distinctly corymbiform inflorescences.

The following contrasts separate *Verbena montevidensis* and *V. brasiliensis* in the USA, where they occur together.

1. Central spikes pedunculate; proximal portions of stems 2–3 mm in diam., glabrous; inflorescence branches glabrous or proximally very sparsely hirsutulous-strigose; calyces 2–2.5 mm, closely strigillose; corolla limbs 1–1.6 mm in diam. ..... **Verbena montevidensis**
1. Central spikes sessile to subsessile; proximal portions of stems (2.5–)2.8–5 mm in diam. sparsely hirsute to hispid or scabrous at least on the angles; inflorescence branches hirsute to strigose-hirsute or hirsutulous; calyces 3–3.5 mm, loosely strigose to hirsute-strigose; corolla limbs (2–)2.5–3.5 mm in diam. ..... **Verbena brasiliensis**

The collection cited above from Sabine Parish, Louisiana (*Allen 9131*), and from Texas localities have gracile stems, pedunculate central spikes, and small flowers with strigillose calyces, but the inflorescence axes are sparsely hirsutulous-strigillose, slightly atypical for *Verbena montevidensis* elsewhere. Occasional plants of *V. montevidensis* where fruiting spikes remain relatively dense may have an aspect of *V. brasiliensis*, but the inflorescence structure, flower size, and vestiture distinguish them.

Key to the species

The five species discussed in the present study can be distinguished by the contrasts here. All but *Verbena litoralis* are recognized to occur in the USA. *Verbena sphaerocarpa* is contrasted with *V. brasiliensis* in the text above.

1. Leaves basally clasping to subclasping.

2. Corolla tubes 4–6(–7) mm, 1.5–2 mm longer than the calyces; distal stems, peduncles, and calyces stipitate-glandular; spikes 8–30 mm in fruit; floral bracts 2.1–2.8 mm; nutlets 1.5–1.9 mm; basal and midstem leaves oblong-lanceolate to oblong-oblanceolate ..... **Verbena bonariensis**
2. Corolla tubes 2.5–4 mm, 0–0.5 mm longer than the calyces; stems, peduncles, and calyces eglandular; spikes 6–55 mm in fruit; floral bracts 3–4 mm; nutlets 1–1.2 (–1.4) mm; basal and midstem leaves ovate to ovate-lanceolate, oblong-elliptic, or obovate ..... **Verbena incompta**

1. Leaves basally attenuate to short-petiolate.

3. Central spikes sessile to subsessile, spikes compact, 3–5 mm wide, fruits remaining densely overlapping at maturity ..... **Verbena brasiliensis**
3. Central spikes pedunculate, spikes loose, 2–3 mm wide, with fruits usually becoming remote at least in the proximal portion at maturity.

4. Fruiting spikes (5–)10–35(–50) mm in fruit, central spikes on peduncles (0–)2–10(–20) mm; inflorescence distinctly corymboid; leaves commonly deciduous by flowering; stems glabrous to glabrate or proximally very sparsely hirsutulous-strigose ..... **Verbena montevidensis**
4. Fruiting spikes 30–150 mm in fruit, central spikes on peduncles 10–40 mm; inflorescence open and loosely paniculate; leaves persistent at flowering; stems sparsely strigose to hirsute-strigose or hispid-hirsute ..... **Verbena litoralis**

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A NEW SPECIES OF *VERBENA* (VERBENACEAE) FROM NORTHEASTERN MEXICO AND AN OVERVIEW OF THE *VERBENA OFFICINALIS* GROUP

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ABSTRACT

Verbena madrensis Nesom sp. nov., is described from Coahuila, Nuevo León, and Tamaulipas in northeastern Mexico. It is most similar to *V. menthifolia* and apparently also closely related to *V. officinalis* and *V. supina*. Seven South American species and three from Africa and Australia also are hypothesized to be closely related to *V. officinalis*. The closest relationship of *V. halei* has sometimes been hypothesized to be with *V. officinalis*, but it apparently is closer to other species native to North America. A key to the five species known either as waifs or naturalized in North America is provided and typification, a description, and commentary is given for each.

KEY WORDS: *Verbenaceae*, *Verbena madrensis* sp. nov., *V. menthifolia*, *V. halei*, *Verbena officinalis*, *V. supina*, taxonomy, USA, Mexico, South America, Galapagos, Australia

In review of the taxonomy of North American *Verbena* toward preparation of the treatment for the Flora of North America volumes, attention has been given to the delimitation of *V. officinalis* L. and its apparent close relatives, including *V. menthifolia* Benth. and *V. supina* L. These species, along with others from Africa, Australia, and South America, are treated by Nesom (2010) within *Verbena* sect. *Verbena* ser. *Verbena*. *Verbena halei* Small has been hypothesized in earlier literature to be most closely related to *V. officinalis* but has been placed in a different series (Nesom 2010). In North America, *V. menthifolia* and *V. halei* are native and *V. officinalis* is naturalized; *V. supina* has been recorded as a waif but does not appear to be naturalized. A previously undescribed species from northeastern Mexico also belongs in ser. *Verbena*.

VERBENA MADRENSIS Nesom, sp. nov. Figs. 1, 2. Type: **MEXICO. Nuevo León**. [Mpio.] Galeana, Hacienda Pablillo, 3 Aug 1936, *M.E. Taylor 49* (holotype: TEX!; isotype: MO!)

Verbenae menthifoliae Benth. similis vestimento plerumque strigilloso, spicis laxis elongatis, et nuculis parvis superficiebus commissuralibus apicem attengentibus sed differt rhachidibus dense persistente glandulosis, foliis incrassatis regulatim grosse serratis marginibus revolutis, bracteis floralibus hispido-hirsutis glandulosis, et corollis majoribus.

Plants perennial herbs, taprooted, sometimes producing basal offsets or basal branches layering (*Hinton 24412*). **Stems** mostly 1 from the base, erect to ascending-erect, 25–60(–120) cm, very sparsely hirsute-strigose, eglandular or sparsely stipitate-glandular. **Leaves** mostly on proximal half of stems, ovate to lanceolate or oblong-lanceolate in outline, lower and midstem 2.5–4(–5) cm x 5–17(–25) mm, margins strongly revolute, coarsely serrate with 3–6 teeth per side, sometimes 3-lobed or pinnatifid, lobes acute, veins slightly impressed adaxially, hispid-strigose adaxially, hispid-hirsute abaxially mostly along the veins, eglandular. **Fruiting spikes** 1 or 3–7 from distal branches, open-elongate or sometimes denser with overlapping fruits, 6–20 cm, rachis densely and persistently stipitate-glandular; floral bracts ovate to ovate-lanceolate, slightly shorter than the calyces, hispid-hirsute, stipitate-glandular, margins ciliate. **Calyces** 2.2–3 mm, hirsute to hirsutulous, densely minutely stipitate-glandular, lobes acuminate-filiform, hispid, not connivent. **Corollas** blue to

purplish pink, tubes (3–)3.5–4.5 mm, 2 mm longer than the calyces, limbs 5–9 mm in diam. **Nutlets** (1.3–)1.5–1.8 mm, longitudinally ridged, commissural faces reaching very tip, minutely papillate to papillate-bullate, rarely bare.

Flowering May–Aug(–Oct). Thorn forest, oak, pine, oak-pine, and oak-fir woods, rocky slopes, dry stream beds, roadsides; 500–2400 m; Mexico (Coahuila, Nuevo León, Tamaulipas).

Additional collections examined. **MEXICO**. **Nuevo León**. Chipinque, pine woodland, 1 Jul 1947, *Barkley et al. 7150* (TEX); Mpio. Linares, Rio Iturbide, IRF Iturbide, 900 m, 30 Sep 1979, *Hinton et al. 17695* (HINTON); Mpio. Aramberri, N of Aramberri, IRF Lampacitos, 995 m, 16 Jun 1990, *Hinton 20329* (TEX); Mpio. Montemorelos, El Pastor, oak woods, 460 m, 19 May 1994, *Hinton 24216* (TEX); Mpio. Santiago. La Nogalera, glade in oak woods, 1005 m, 16 Jun 1994, *Hinton 24412* (TEX-2 sheets); Mpio. Santiago, Blanquillo, bushy hillside, 540 m, 22 Jun 1994, *Hinton 24440* (TEX); Mpio. Galeana, Hacienda Cieneguillas on Cerro Potosí, open, dry, rocky slopes in chaparral, 8000 ft, 11 Aug 1938, *Mexican Biol. Exped. Univ. of Illinois 992* (ARIZ); Sierra Madre Mts, Monterrey, 18 Jul 1933, *Mueller 157* (TEX); Mpio. Villa Santiago, Canon Denuncio, common in less dense oak wood of upper canyon, 22 Jun 1935, *Mueller 2010* (MO); Montemorelos, 3 Apr 1902, *Nelson 6096* (MO); 5 mi SE of Monterrey on Hwy 85 and 2 mi W of Valle Alto, thorn forest and dry stream bed, limestone and shale, 14 Jul 1971, *Parker 424* (TEX); Chipinque Mesa, 1900 ft, 2 Aug 1970, *Roberts 57* (TEX); Linares, 4 Jun 1971, *Seigler and Becker OS-3149* (MO, TEX); 1 mi down road from Chipinque, Monterrey, Apr 1961, *Smith 476* (TEX); Hacienda Vista Hermosa, 35 mi S of Monterrey, ca. 2200 ft, 27 Jun 1939, *White 1577* (ARIZ). **Tamaulipas**. Sierra de San Carlos, Cerro del Diente, 17 km S de San Carlos, 1100 m, bosque mesofilo de montana con *Abies*, *Quercus*, *Staphylea*, etc, 22 May 1988, *Hernandez 2246* (TEX); Sierra de San Carlos, ca 5 mi S of San Carlos, near top of slope, igneous bedrock, open woods of scattered oaks and pines, ca. 1200 m, 18 Jun 1987, *Nesom 6141* (TEX).

Verbena madrensis is recognized by its single-stemmed habit, glabrate stems with sharp, strongly nerved angles, widely spaced and elongate leaves with coarsely serrate, revolute margins, loose, elongate spikes in panicles at the apices of the stems and branches, persistently and densely stipitate-glandular rachises, hirsute to hirsutulous and stipitate-glandular floral bracts and calyces, short corolla tubes, and nutlets with commissural faces reaching the tip. The oblong-lanceolate cauline leaves with sharp, slightly recurving teeth are reminiscent of those of *V. canescens*, but the nutlet comissural faces in *V. madrensis* reach all the way to the nutlet tip, like those of *V. officinalis* and *V. menthifolia*.

Among North American species, *Verbena madrensis* is closely similar to *V. menthifolia* Benth. Moldenke (1964) cited *Mueller 157*, *Mueller 2010*, and *Taylor 49* (above, as *V. madrensis*) among plants he identified as *V. menthifolia*. The geographic range of *V. madrensis* lies at the northeastern corner of that of *V. menthifolia*, essentially allopatric with it, and is much smaller in comparison. From Nuevo León, in the region where *V. madrensis* is common, I have seen only a single collection of *V. menthifolia*: 32 mi S of San Roberto, along Hwy 57, near small pond, 6000 ft, 11 Jul 1963, *McGregor et al. 492* (SMU). Two collections from southeastern Coahuila are *V. menthifolia*: Sierra de la Concordia, 6 km NE del Ejido La Casita, 25° 14' 05" N 101° 25' 25" W, bosque de *Pinus cembroides*, *Quercus laeta*, *Q. saltillensis*, *Arbutus xalapensis*, y *Garrya wrightii*, canyones y ladera media de exposicion oeste, 2100–2300 m, 10 Oct 1996, *Encina 288* (TEX). Mpio. Arteaga. Los Lirios→El Cercado, roadside in pine and oak woods, 1 m tall, 2405 m, 29 Jul 1995, *Hinton et al. 25422* (HINTON-digital image!). I have not seen a collection of *V. menthifolia* from Tamaulipas.

The two species are distinguished by the following contrasts.

1. Leaf margins regularly, coarsely serrate, revolute; inflorescence rachis densely and persistently stipitate-glandular; floral bracts hispid-hirsute, stipitate-glandular; corolla tubes (3–)3.5–4.5 mm, 2 mm longer than the calyces, limbs 5–9 mm in diam. ..... **Verbena madrensis**
1. Leaf margins deeply and irregularly toothed to lobed, not revolute or only slightly so; inflorescence rachis eglandular or rarely sparsely stipitate-glandular and quickly becoming eglandular; floral bracts glabrous to sparsely strigillose, eglandular to sparsely stipitate-glandular; corolla tubes 2.5–3 mm, 0.5–1 mm longer than the calyx, limbs 1.5–3(–5) mm in diam. ..... **Verbena menthifolia**

Features in common between *Verbena madrensis* and *V. menthifolia* are a mostly strigillose vestiture, elongate, slender spikes of remote flowers and fruits (not overlapping each other on the spikes), relatively small corollas, and small nutlets with commissural faces reaching the nutlet tip. The European native *V. officinalis* also is closely similar. A close relationship between *V. menthifolia* and *V. officinalis* was hypothesized by Perry (1933), who also included *V. halei* as a member of this group. She noted that distinctions of *V. menthifolia* are "perhaps … differences only of degree and may be merely variations of *V. officinalis*; nevertheless, for the present it seems prefereable to retain the name *V. menthaefolia* for the American representative" (p. 265). The present study confirms their distinction. These species, along with another that is newly described in this manuscript, can be distinguished by the following contrasts.

1. Stems mostly prostrate to decumbent-ascending; mid-cauline leaves triangular to deltate or ovate-cuneate in outline ..... **Verbena supina**
1. Stems mostly erect; mid-cauline leaves ovate to lanceolate or oblong-lanceolate in outline.

2. Leaves mostly basal and lower cauline, distal cauline become linear and entire; leaf margins revolute; commissural faces ending below the nutlet tips ..... **Verbena halei**
2. Leaves evenly distributed along stems, often largest at midstem, proximal and distal cauline similar in morphology; leaf margins not revolute or only slightly so; commissural faces reaching the nutlet tips.

3. Rachis eglandular or nearly so. ..... **Verbena menthifolia**
3. Rachis persistently stipitate-glandular.

4. Corolla tubes 2.5–3 mm, 0.5–1 mm longer than the calyces, limbs 2–3 mm in diam; leaf margins coarsely and unevenly crenate to incised-crenate or crenate-serrate, not revolute or only slightly so ..... **Verbena officinalis**
4. Corolla tubes (3–)3.5–4.5 mm, 2 mm longer than the calyces, limbs 5–9 mm in diam; leaf margins regularly coarsely serrate, narrowly revolute ..... **Verbena madrensis**

VERBENA MENTHIFOLIA Benth., Pl. Hartw., 21. 1839. **TYPE**: **Mexico**. [Guanajuato]. Leon, 1839, [no other collection information], *Hartweg 175* (holotype: K, photo-MO!; isotype: NY, digital image!). The protologue: "175. VERBENA (Euverbena) *menthaefolia*, sp. n., caule erecto ramoso pilosiusculo, foliis obovato-cuneatis subincisis laciniis acutiusculis grosse dentatis, spicis elongatis gracilibus paniculatis, bracteis parvis, corollis calyce triplo longioribus, fructibus remotis."

Verbena hintonii Moldenke, Phytologia 1: 439. 1940. **TYPE**: **Mexico**. Michoacan. Distr. Zitacuaro, Zitacuaro–Bosque, grassy bank, 28 Jun 1938, *Hinton et al. 11991* (holotype: NY-digital image!; isotypes: F-digital image!, GH, HINTON-digital image!, MICH, TEX!, US-digital image!, WTU).

Verbena setosa Mart. & Gal., Bull. Acad. Roy. Sci. Bruxelles 11: 321. 1844. **TYPE**: **Mexico**. Hidalgo. "Dans les forêts de Moran, près de Real del Monte, et del Sabino, près d'Izmiquilpan, au nord de Mexico, de 6000–7500 ft," fl. lilas, Août 1840, *H.G. Galeotti 778* (holotype: BR, photo-LL!, photo-MO!). The type of *V. setosa* is not currently listed in the online account of BR types.

Verbena carolina forma *albiflora* Moldenke, Phytologia 7: 430. 1961. **TYPE**: **Mexico**. Sonora. Region of the Rio de Bavispe, Cañón de El Temblor, 19 Aug 1940, *S.S. White 3379* (holotype: MICH digital image!). O'Leary et al. (2010) treat this as a synonym of *V. carolina*.

Verbena comonduensis Moldenke, Phytologia 18: 343. 1969. *Verbena menthifolia* var. *comonduensis* (Moldenke) Moldenke, Phytologia 46: 155. 1980. **TYPE**: **Mexico**. Baja California. Comundu, common roadside weed for 10 miles in either direction, 19 Mar 1969, *A.F. and A.R. Moldenke 2922* (holotype: LL!). Topotype: Comondu, moist sandy depressions on flats along roadside, 21 Apr 1971, *Moldenke and Moldenke 25407* (LL, TEX).

Plants perennial herbs, usually taprooted (rarely with basal offsets, *Encina 288*, TEX). **Stems** mostly 1–3 from the base, erect, (30–)40–70 cm, sparsely strigose to hirsute-strigose along the ridges with appressed to ascending hairs, eglandular. **Leaves** relatively evenly distributed, on stems, even-sized or sometimes largest at midstem, ovate to broadly lanceolate in outline, midstem blades 2.5–4.5(–8) cm x 15–25(–40) mm, strigose-hirsute to hirsute-strigose abaxially, strigillose to hirsute-strigose adaxially, eglandular, margins not revolute or only slightly so, deeply toothed to pinnately lobed, sometimes evidently 3-lobed through a pair of large proximal divisions, divisions ovate-oblong to triangular, subpetiolate. **Fruiting spikes** (1–)3–12 in panicles, elongate and slender, 10–20(–30) cm, rachis eglandular to sparsely stipitate-glandular; floral bracts ovate-lanceolate, 1.5–2 mm, shorter than the calyces, glabrous to sparsely strigillose, eglandular, margins ciliate. **Calyces** 2.3–3 mm, closely to loosely strigillose with even-length hairs, eglandular to very sparsely stipitate-glandular (moderately sessile-glandular in Sonora and D.F.), lobes deltate to triangular, not connivent to subconnivent. **Corollas** blue to purple, tubes 2.5–3 mm, 0.5–1 mm longer than the calyx, limbs 1.5–3(–5) mm in diam. **Nutlets** separating at maturity, 1.4–1.8(–2) mm, commissural faces extending completely to the nutlet tips, minutely acicular-papillate.

Flowering Apr–Jun. Canyon bottoms, around springs and tanks, river and canal banks, wet places in arid habitats (USA); 50–1200 m; Arizona, California, New Mexico, Texas; Mexico (Aguascalientes, Baja California, Baja California Sur, Chihuahua, Coahuila, Distrito Federal, Durango, Guanajuato, Hidalgo, Jalisco, México, Michoacan, Morelos, Nuevo León, Oaxaca, Querétaro, Puebla, San Luis Potosí, Sinaloa, Sonora, Veracruz, Zacatecas); introduced in Europe. Attributions of *V. menthifolia* to Chiapas and Guatemala are based on collections discussed under *V. officinalis*.

Verbena menthifolia is known to me from Texas by only a single collection. **Texas**. Brewster Co.: Black Gap Refuge, Horse Canyon, 100 mi S of Alpine, infrequent perennial around old dirt tank, limestone soil, 2000 ft, 24 Jun 1950, *Warnock & Hinkley BG-108* (SMU). Moldenke (1964a) cited two other collections: [Bexar Co.?]: between Kerrville and San Antonio, *Jones 28294* (POM); Uvalde Co.: W of Uvalde, 26 Apr 1931, *Jones s.n.* (POM)—I have not seen these but it is improbable that they are *V. menthifolia*.

Peterson and David (1998, p. 23) recorded the occurrence of *Verbena menthifolia* in Chaves Co., New Mexico, as "Occasional in lowlands and arroyos and on roadsides" in Bitter Lake National Wildlife Refuge, northwest of Roswell. This report has been the basis for citation of *V. menthifolia* as an element of the New Mexico flora in various accounts (Martin & Hutchins 1981; Allred 2009; USDA, NRCS 2010; Kartesz 2010). A voucher for this, however, has not been located in the present study, and a New Mexico collection of *V. menthifolia* is not found in NMC, UNM, or SJNM. That species would be considerably out-of-range and out-of-habitat in Chaves County, and I speculate that

the plants observed there by Peterson and David probably were *V. halei* at the northwestern corner of its range.

On the other hand, a collection from New Mexico cited by Moldenke (1963) and repeated in various other accounts as *Verbena halei* proves instead to be *V. menthifolia*. Otero Co.: sand dunes west of Alamogordo, 3 May 1930, *M.E. Jones 26229* (DS-digital image!). The distalmost leaves on this plant are linear and entire (as characteristic of *V. halei*), but the stem is strictly erect and sparsely strigose, the basal leaves are deciduous, the cauline narrowly elongate and narrowly lobed, and the spikes are relatively short and few-flowered compared to typical *V. halei*.

Verbena menthifolia has been collected abundantly in California (at least from San Bernadino, San Diego, Los Angeles, and Riverside counties) and Arizona (Pima, Pinal, and Yuma counties) and in Mexico (states as cited above).

Verbena menthifolia from Hidalgo, Edo. Mexico, and Distrito Federal sometimes has stems, leaves, and calyces with vestiture variable toward strigose-hirsute with uneven length hairs, but like other plants of the species over the rest of its range, they are essentially eglandular and produce small corollas. An Arizona plant identified and studied by Yuan and Olmstead (2008) as *Verbena menthifolia* was heterozygous at both the PHOT1 and PHOT2 nuclear gene loci, and the gene trees indicated that the individual was of hybrid origin, with *V. halei* as one of the putative parental species. I have not been able to study a voucher for this record, but at least it is clear that *V. halei* does not presently occur sympatrically with *V. menthifolia*.

VERBENA SUPINA L., Sp. Pl. 1: 21. 1753. **TYPE**: "Habitat in Hispania." **LECTOTYPE** (Moldenke 1965, p. 255): "Hispania," *Loefling 16* (S9.1, Linnaean Herbarium Stockholm digital image!). See detailed comments by Munir (2002).

Verbena supina L. forma *erecta* Moldenke, Phytologia 11: 259. 1965. *Verbena supina* L. var. *erecta* (Moldenke) Munir, J. Adelaide Bot. Gard. 20: 62. 2002. **TYPE**: **Spain**. Lieux incultes, Algeciras, 24 Jun 1887, *E. Reverchon 81* (holotype: GB, photo-NY fide Moldenke 1965, photo-TEX!; isotypes: BR, S).

Plants annual or weakly perennial herbs, taprooted, sometimes with adventitious roots on the proximal, procumbent portions of the stems. **Stems** branching profusely from crown, procumbent to decumbent-ascending, less commonly erect to erect-ascending, (10–)15–35(–50) cm, sparsely to moderately hirsute-strigose to hirsute, hairs sometimes slightly deflexed, eglandular to sparsely stipitate-glandular. **Leaves** evenly distributed and relatively even-sized, triangular to deltate or ovate-cuneate in outline, midstem blades 2–4 cm x 1.5–2.5 cm, strigose to hirsute-strigose or hirsute, eglandular to stipitate-glandular, margins revolute, coarsely toothed with ovate to oblong-ovate or obovate teeth or divisions to 1–2-pinnatisect, often 3(–5)-lobed, margins veins impressed adaxially; petioles 5–12 mm. **Fruiting spikes** 1 or 1–3, initially dense but elongating and fruits becoming looser and remote, 1.5–3(–5) cm; rachis strigillose, minutely sessile- to short-stipitate-glandular; floral bracts linear-lanceolate to oblong, 1–1.5 mm, shorter than the calyces. **Calyces** 1.8–2 mm, hirsutulous-hirtellous to hirsutulous-strigose, minutely stipitate-glandular, lobes subulate, not connivent. **Corollas** blue to purplish or lilac, tubes 2–2.5 mm, 0.5–1 mm longer than the calyces, limbs 1.5–2.5 mm in diam. Nutlets separating at maturity, 1.8–2.2 mm, commissural faces extending fully to nutlet tips, bare. $2n = 14$.

Flowering mostly spring–summer. Dry and wet places, grasslands, disturbed sites, at a wide range of elevation; Mediterannean Europe, Asia, Africa; naturalized in northern Europe and Eurasia, Asia, Africa, Atlantic Islands (Canary Islands), Pacific Islands (New Zealand), Australia.

Verbena supina was recorded from Alabama by Moldenke (1965), based on waifs collected from along Mobile Bay in 1892 and 1893. The species has not been recorded since that time from anywhere in the USA and is not considered part of the naturalized flora of North America. Alabama. [Mobile Co.]: Hunter's Wharf, 5 Sep 1892, *Mohr s.n.* (US-2 sheets); Mobile, Jul 1893, *Mohr s.n.* (NY)—both Mohr collections as cited by Moldenke.

Common names for *Verbena supina* are trailing vervain and carpet vervain, reflecting its characteristically prostrate habit. Other distinctive and diagnostic features are the deltate to ovate (in outline) and relatively small leaves, relatively short spikes, loosening proximally but remaining compact in the distal 1/3–2/3, short floral bracts, small corollas, fruits with comissural faces extending fully to the nutlet tips, and characteristic stipitate-glandularity, at least sparsely. Munir (2002) observed that in *Verbena supina* in Australia, the commissural faces of the nutlets always are smooth and the vegetative parts are eglandular, while in other parts of the native and naturalized range, plants sometimes are stipitate-glandular and the commissural faces papillate.

The distinctiveness of *Verbena supina* var. *erecta*, was emphasized by Munir, who noted (p. 64) that "the possibility of mistaking this taxon with the typical form would be minimal." And (p. 62 and 64) "The var. *erecta* is closely related to the typical variety in having almost similar shaped leaves, inflorescence, calyx, corolla and mericarps … [but] … differs from the typical form of the species in having its stems usually erect or suberect from the beginning, usually robust and purplish, almost glabrous and shiny or very sparsely puberulous. Leaves usually glabrous adaxially, puberulous on the veins abaxially, lobes obtuse or rounded at the apex." Munir also noted that var. *erecta* is known to occur in several countries of Eastern Europe, North Africa, and the Middle East. In context of Munir's account as summarized here, it appears that var. *erecta* would be appropriately treated at specific rank. Without commenting on patterns of variability, O'Leary et al. (2010) noted only that "El análisis del ejemplar tipo permitió determinar que este taxón es un sinónimo de *V. supina*."

VERBENA OFFICINALIS L., Sp. Pl. 1: 20. 1753. **TYPE**: "Habitat in Europae Mediterraneae ruderatis," probably from central Europe (see Michael 1997). **LECTOTYPE** (Verdcourt in Jarvis et al., Regnum Veg. 127: 98. 1993): Herb. Clifford: 11, Verbena 6, sheet 6 (BM).

Verbena officinalis L. var. *prostrata* Gren. & Godr., Fl. France 2: 718. 1853. **TYPE**: **France**. Sables des environs de Bayonne, bords des chemins et décombres, Jun-Oct, no collector or date specified. Described in the protologue simply as "Tige étalée-couchée."

Verbena spuria L., Sp. Pl. 1: 20. 1753. *Verbena officinalis* L. var. *spuria* (L.) Hook., Companion Bot. Mag. 1: 176. 1836. **TYPE**: O'Leary et al. (2010) designated (from photos) "*Muhlenberg 68*," "PH 3073 no visto" as the neotype. Typification of *V. spuria* is under further study by Nesom (in manuscript).

Verbena riparia Raf. ex Small & Heller, Mem. Torrey Bot. Club 3: 12. 1892. *Verbena urticifolia* var. *riparia* (Raf. ex Small & Heller) Britton, Mem. Torrey Bot. Club 5: 276. 1894. **LECTOTYPE**: (Moldenke 1964, p. 101): **USA**. North Carolina. Caldwell Co: Along the John's River near Globe, 3 Jul 1891, *J.K. Small s.n.* with A.A. Heller (NY-digital image!; isolectotype: MO!). O'Leary et al. (2010) designated a lectotype for this, not realizing that it had been done previously.

Verbena domingensis Urb., Symb. Antill. 5: 484. 1908. **LECTOTYPE** (O'Leary et al. 2010): **Hispaniola**. Dominican Republic. Ad Angostura del Rio Yaqui, "in rupibus calcareis, ad ripam fluminis," 210 m, 8 May 1887, *H.F.A. von Eggers 1828* (NY-digital image!). Placed by O'Leary et al. (2010) as a synonym of *V. menthifolia*.

Verbena russellii Moldenke, Phytologia 2: 55. 1941. **TYPE**: **Mexico**. Sinaloa. Vicinity of Culiacan, moist field, 21 Apr 1910, *J.N. Rose 14850* (holotype: NY digital image!; isotypes: US digital

image!). O'Leary et al. (2010) placed *V. russellii* as a synonym of *V. neomexicana* var. *neomexicana*.

Verbena domingensis Urb. var. *cubensis* Moldenke, Phytologia 50: 309. 1982. **Type: Cuba.** Campo Florido, 13 Mar 1905, *A.H. Curtiss 677* (holotype: NY-digital image!; isotype: F-digital image!). Placed by O'Leary et al. (2010) as a synonym of *V. menthifolia*.

Verbena domingensis Urb. forma *foliosa* Moldenke, Phytologia 34: 19. 1976. **Type: Hispaniola**. Dominican Republic. [Prov.] Pedernales. Near Canote, ca. 5 mi W of Aceitillar, Baoruco Mts., in thickets at the bottom of the gorge, ravine on limestone, 1400 m, 9 Nov 1969, *A.H. Liogier 16846* (holotype: NY-digital image!). Placed by O'Leary et al. (2010) as a synonym of *V. menthifolia*.

Plants annual or weakly perennial herbs, taprooted. **Stems** mostly 1 from the base, erect, 30–140 cm, glabrous to scabrous to sparsely hispid-strigose or hirsute-strigose along the angles, eglandular, becoming sparsely stipitate-glandular distally into the inflorescence. **Leaves** relatively evenly distributed on stems, narrowly obovate to oblanceolate or lanceolate in outline, midstem blades 2–7 cm x 8–40 mm, even-sized or sometimes largest at midstem, hirsute-strigose abaxially and adaxially, eglandular at maturity but stipitate-glandular abaxially when young, margins coarsely and unevenly crenate to incised-crenate or crenate-serrate, basal often 3-lobed or rarely pinnately lobed, not revolute or only slightly so; petioles 5–15(–20) mm, narrowly or broadly winged. **Fruiting spikes** (3–)5–15 in panicles, elongate and slender, 3–15 cm, rachis sparsely stipitate-glandular; floral bracts ovate-acuminate to triangular, 1.5–2 mm, shorter than the calyces. **Calyces** 2–2.2 mm, hirsute to hispid-strigose, minutely stipitate-glandular, lobes shallowly deltate, not connivent. **Corollas** blue to purplish, rarely pink, tubes 2.5–3 mm, 0.5–1 mm longer than the calyces, limbs 2–3 mm in diam. **Nutlets** separating at maturity, 1.4–2 mm, commissural faces reaching the nutlet tips, acicular-papillate, rarely bare. $2n = 14$.

Flowering Jun–Aug. River banks, dunes, roadsides, ballast; 5–700 m; introduced; Alabama, California, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Mississippi, New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Virginia, Washington, West Virginia, Wisconsin; Europe, Asia; introduced also in West Indies, Bermuda, South America (Chile), Asia (Bhutan, China, India, Japan, Pakistan, Thailand), Africa (Canary Islands, Natal, South Africa), Atlantic Islands (Azores), Pacific Islands (New Zealand), Australia. Records from Colorado, Mississippi, New Mexico, Oregon, and Wisconsin (as reported by PLANTS Database) have not been confirmed in the present study.

Some plants in New York state are identified by the PLANTS Database as *Verbena officinalis* var. *prostrata*, perhaps based on the record in House (1924, p. 589), but House identified the New York plants as *V. officinalis*, citing "*V. spuria* L.; Torr. Fl. N.Y. 2: 52. 1843" only as a synonym.

Verbena officinalis is not common in the USA outside of cultivation. At least some collections perhaps reflect plants that are persistent from cultivation and not clearly naturalized. Plants and populations along river banks in montane North Carolina, Tennessee, Virginia, and West Virginia, however, apparently have long been established, apparently naturalized, and often identified as *V. riparia*. It seems unusual that they would already have been well-established in these habitats by the time that Rafinesque observed them (in the 1820s or 1830s), but they appear to be similar to *V. officinalis* in all features. On the other hand, a number of collections identified as *V. officinalis* were made in the same regions in the 1840s through the 1890s—from Alabama, Delaware, Georgia, New Jersey, New York, North Carolina, Pennsylvania, Tennessee, Virginia, and others— suggesting that this species perhaps was cultivated at that time for its medicinal properties and commonly escaped to become more abundant then than it is now.

Additional collections identified as "*Verbena riparia*" (if not with exclamation, then as cited by Small and Vail 1893; Perry 1933; Moldenke 1964c). **North Carolina**. Stanly Co.: near falls of Yadkin, 18 Aug, 1891, *Small and Heller s.n.* (F). **Virginia**. [Isle of Wight County]: Ragged Island, [date], *Fernald and Long 12453* (NY). Smyth Co.: banks of Staley Creek at Marion, valley of Middle Fork of Holston River, 2200 ft, 16-? May 1892, *Small and Vail s.n.* (NY); banks of Cedar Creek, valley of Middle Fork of Holston River, 1900 ft, 16-? May 1892, *Small and Vail s.n.* (NY); bluffs of Middle Fork Holston River, near Marion, 2100 ft, 22 Jun 1892, *Small s.n.* (NY, OKL, TEX!, UC); Middle Fork, Holston River, 2100 ft, 1 Jul 1892, *Small s.n.* (BH-3 sheets, CAS, CINC, CM, DUKE, FLAS, NCU, NY, P, PENN, POM, US, WVA); Marion, 2100 ft, 6 Jul 1892, *Small s.n.* (ARIZ, GH, MO); Middle Fork Holston River, 6 Jul 1892, *Small s.n.* (CAN, CS, ISC, MO, NY-2 sheets, NYS, OC, US); about Marion, 2100 ft, 20 Jul 1892, *Small s.n.* (MO); Marion, Middle Fork Holston River, 6 Jul 1922, 2100 ft, *Small s.n.* (MO, SMU).

These collections, also from riverbanks and clearly the same species as those cited above as "*Verbena riparia*," were identified as *V. officinalis*: **Tennessee**. Carter Co.: banks of Doe River, 16-17 Jul 1891, *Small and Heller 84* (SMU), *Small and Heller 484* (MO); Knox Co.: Knoxville, roadside, Jul 1893, *Ruth s.n.* (MO). **Virginia**. Marion, 2100 ft, 29 Jun 1892, *Small s.n.* (MO)

In the protologue of *Verbena domingensis*, Urban (1908) noted that *V. officinalis* differs from *V. domingensis* in its more branching stems, smaller, mostly toothed (vs. pinnatifid or pinnately parted) leaves, and smaller flowers. Perry (1933) treated *V. domingensis* as a synonym of *V. officinalis*, but it was maintained as distinct by Moldenke (1964) and by Liogier (1957, 1994). The type collections of *V. domingensis* var. *cubensis* and *V. domingensis* forma *foliosa* appear to be of plants typical of *V. officinalis* in leaf morphology, suggesting that the smaller-leaved plants probably are populational variants of naturalized *V. officinalis*.

Early reports of *Verbena officinalis* from the Valley of Mexico confused its identification with *V. menthifolia* (fide Rzedowski & Rzedowski 1985). Moldenke (1964) cited as *V. officinalis* only a single collection from Mexico: Nuevo León, *Pennell 16880*, PH, MEXU, US); I have not seen this collection but the plants are probably *V. madrensis* or *V. menthifolia*. Most other collections from western states (e.g., Chihuahua, Durango, Sonora) originally determined as *V. officinalis* have proved to be *V. menthifolia*.

Verbena russellii Moldenke (cited above) from Sinaloa is unequivocally is *V. officinalis* sensu stricto. The only other representative of *V. officinalis* I have seen from Mexico was collected from the same immediate area as the type of *V. russellii*: Sinaloa. Maraton, 12 mi W of Culican, heavy clay of coastal plain, thorn forest, 100 ft, common annual, 14 Mar 1944, *Gentry 7011* (ARIZ).

A collection from Guatemala was cited as *Verbena menthifolia* by Moldenke (1964a) and Gibson (1970): Huehuetenango, between Nenton and Las Palmas, *Steyermark 51655* (US; cited by O'Leary et al. 2010 as *V. menthifolia*). I have not seen the Guatemala specimen, but distinctive plants (CAS-DS, TEX-LL, MO) from adjacent southeastern Chiapas, e.g., Amatenango del Valle, Comitán de Dominguez, Frontera Comalapa, Venustiano Carranza, near Trinitaria, near Cuahtémoc, and others, probably represent the same entity, definitely not *V. menthifolia*. These plants have relatively few spikes in a panicle, the fruits becoming remote proximally, and glandular rachises, but the leaves are uncharacteristically elongate (oblong-lanceolate) and the teeth and lobes are sharp-pointed. They are remarkably similar to the Australian native *V. officinalis* var. *gaudichaudii* Briq., recognized by Michael (1997) at specific rank. If not that same entity, they will be justifiably treated as a distinct species, previously undescribed.

Michael (1997) segregated at specific rank three native Australian taxa often identified as infraspecific taxa of *Verbena officinalis*: *V. macrostachya* F. Muell. (= *V. officinalis* var. *macrostachya* (F. Muell.) Benth.), *V. gaudichaudii* (Briq.) P.W. Michael (= *V. officinalis* var. *gaudichaudii* Briq.), and *V. africana* (Fernand. & Verdc.) P.W. Michael (= *V. officinalis* subsp. *africana* Fernand. & Verdc.). These taxa differ in vestiture, leaf shape, and corolla size, their treatment as species correlative with Michael's observation only that they are "sufficiently distinct" from *V. officinalis* sensu stricto, which is naturalized in Australia. Munir (2002), however, treated these three at varietal rank within *V. officinalis*, adding *V. officinalis* var. *monticola* Munir (native), *V. officinalis* var. *eremicola* Munir (native), and *V. officinalis* var *halei* (introduced) as inhabitants of Australia. Munir's explicit rationale also was minimal — he noted (p. 80) that "the present author believes that the above-named infraspecific taxa do not merit the status of species because they differ from the typical form chiefly by the size of their spikes and flower parts and dentation of leaf blades. These characters are very variable and there are intermediates between these taxa."

In review of the Australian taxonomic pattern, and to use Munir's ranks, vars. *gaudichaudii* and *africana* occur over broad ranges and are mostly sympatric with each other; each of vars. *eremicola*, *monticola*, and *macrostachya* has a narrowly restricted range and is allopatric with the other two, but all three occur within the broader ranges of vars. *gaudichaudii* and *africana*; var. *officinalis* and var. *halei* are each known from scattered collections over a broad area, essentially sympatric with vars. *gaudichaudii* and *africana*. Verdcourt (1992) observed that two entities—*V. officinalis* sensu stricto and *V. africana* sensu Michael—with "quite marked" differences occur together in South Africa. If morphology supports distinct recognition of the five Australian endemics, then each of them probably is appropriately treated at specific rank. *Verbena halei* clearly should be treated so.

In addition to those discussed above, a group of South American species also is hypothesized to be closely related to *Verbena officinalis*: *V. cannuensis* Moldenke, *V. demissa* Moldenke, *V. filicaulis* Schauer, *V. gracilescens* (Chamisso) Herter, *V. grisea* Rob. & Greenm., *V. swiftiana* Moldenke, and *V. townsendii* Svenson. These species are discussed in relation to the formal delimitation of series *Verbena* (Nesom 2010).

VERBENA HALEI Small, Bull. Torrey Bot. Club 25: 617. 1898. *Verbena officinalis* L. subsp. *halei* (Small) S. C. Barber, Syst. Bot. 7: 454. 1982. *Verbena officinalis* L. var. *halei* (Small) Munir, J. Adelaide Bot. Gard. 20: 93. 2002. **LECTOTYPE** (Moldenke 1963, p. 162): **USA**. Louisiana. No other collection information, *Dr. J. Hale 245* (NY-digital image!). Small cited "Hale 245," but the last digit of the collection number on the type label is somewhat ambiguous (either "5" or "3").

Verbena leucanthemifolia Greene, Pittonia 5: 135. 1903. **TYPE**. **USA**. Texas. Taylor Co.: Abilene, 19 May 1902, *S.M. Tracy 7996* (holotype: ND-G 43312; isotypes: GH, MO!, MSC, NY-digital image!, TEX! digital image!, US-digital image!). The ND-G sheet has the annotation of "type" in Greene's hand, fide Barbara Hellenthal.

Plants short-lived perennial to annual, taprooted. **Stems** mostly 1–3 from the base, erect, (25–)40–80 cm, glabrate to scabrous, or sparsely hirsute-strigose with upturned hairs on the ridges, eglandular. **Leaves** (basal and lower cauline) spatulate to ovate or oblong-obovate, margins coarsely toothed to incised, revolute, cauline reduced in size and narrower, 1–2-pinnatifid, upper cauline commonly bracteate, linear and entire, veins impressed adaxially, basal and proximal blades 2–6 cm x 7–25(–30) mm, strigose to strigillose adaxially, hirsute to hispid-hirsute abaxially, eglandular; petioles 10–60 mm. **Fruiting spikes** (3–)5–15 in panicles, elongate and slender, 8–25 cm, rachis eglandular; floral bracts ovate-lanceolate, 1.6–2.5 mm, shorter than the calyces. **Calyces** 2.2–3.2 mm, strigillose, eglandular, lobes deltate to triangular, not connivent. **Corollas** bluish to lavender-blue or purple,

rarely white, tubes 3–4 mm, 0.8–1 mm longer than the calyx, limbs 4–5(–7) mm in diam. **Nutlets** separating at maturity, 1.6–2 mm, commissural faces ending below the nutlet tips, with bullate to papillate plates. 2n = 14.

Flowering Mar–Jun(–Oct). Rocky hillsides, prairies, pastures, fields, beaches, dunes, shell banks, post oak, pine, cedar glades, oak-mesquite, mesquite, roadsides, disturbed sites; 5–200(–800) m; Alabama, Arkansas, Florida, Georgia, Louisiana, Missouri, Mississippi, North Carolina, Oklahoma, South Carolina, Texas; Mexico (Coahuila, Nuevo León, Tamaulipas, Sonora, Veracruz); introduced in Australia.

Verbena halei is a distinctive North American species. With *V. officinalis* it shares closely strigillose calyces, small corollas, and mostly glabrate to sparsely hirsute-strigose stems, but the two taxa are continentally disjunct in native range and discontinuous in morphology. *Verbena halei* is completely eglandular, it produces more numerous spikes often in congested panicles, and the leaves are primarily basal and proximal and thicker with revolute margins and veins impressed adaxially.

Barber's submergence of *Verbena halei* into *V. officinalis* (1982) was based on her encounter of specimens of the former misidentified as the latter. "These misidentifications were often justified because the plants would really fit neither taxon because of some intermediate character exhibited by the specimen. The problem of deciding which species a specimen belongs to would be solved with the merger …" (p. 452). In contrast to Barber's assessment, and in agreement with Perry (as noted above), *V. officinalis* is as similar or more to *V. menthifolia* than to *V. halei* (though probably not most closely related to each other (see Nesom 2010). And because of the rarity of *V. officinalis* (naturalized or otherwise) within the geographic range of *V. halei*, the two rarely if ever have the opportunity even to hybridize, much less to intergrade. They can be separated by these contrasts.

1. Basal and lower cauline leaves persistent, relatively thick, large and spatulate, margins revolute, cauline leaves quickly reduced in size distally and becoming linear-entire; rachis and calyces eglandular ..... **Verbena halei**
1. Basal leaves usually deciduous, relatively thin, margins not revolute, cauline leaves relatively even-sized upwards or largest near midstem; rachis and calyces stipitate-glandular ..... **Verbena officinalis**

Moldenke (1963) cited collections of *Verbena halei* from Durango (*Waterfall & Wallis 13371*, TEX, = *V. menthifolia*!), Querétaro (*Arsene 10242*, MO! = *V. menthifolia*!), Sinaloa (*Gentry 7011*, ARIZ, = *V. officinalis*!, see comments above), and Chihuahua (*Pringle s.n.*, 11 Apr 1887, not seen). All other collections that I have seen from Chihuahua, Durango, Sinaloa, and Sonora identified as *Verbena halei* by Barber and by Moldenke have instead been *V. menthifolia*. Collections identified as *V. halei* from Arizona (SEINET 2009; Kearney & Peebles 1960; Moldenke 1963) either have proved to be or apparently are *V. menthifolia*. I have not seen evidence that *V. halei* occurs further west in the USA than Texas. The single collection upon which attribution of *V. halei* to the New Mexico flora has been based (Otero Co., *Jones 26229*) is identified here as *V. menthifolia* (see comments above). A collection from southeastern New Mexico previously identified as *V. menthifolia* (Chaves Co., as cited by Peterson and David 1998, see comments above under *V. menthifolia*) instead probably is *V. halei*, but I have not seen a voucher.

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Figure 1. Holotype of *Verbena madrensis* Nesom.

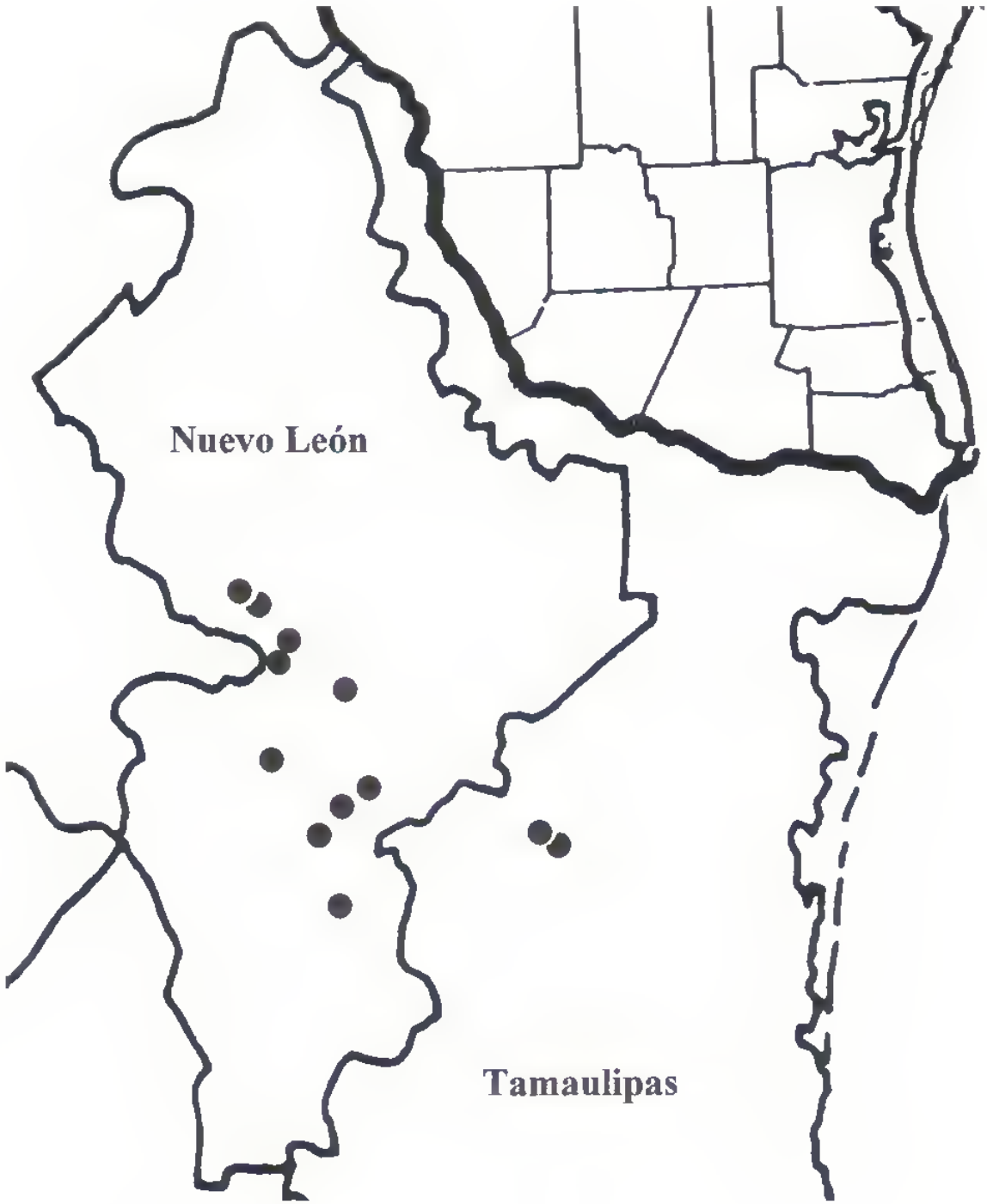

Figure 2. Geographic distribution of *Verbena madrensis* Nesom

Nesom, G.L. 2010. Taxonomy of *Verbena urticifolia* (Verbenaceae) and its close relatives. Phytoneuron 2010-14: 1–12.
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TAXONOMY OF *VERBENA URTICIFOLIA* (VERBENACEAE) AND ITS CLOSE RELATIVES

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ABSTRACT

Verbena urticifolia L., *V. scabra* Vahl, and *V. carolina* L. are distinct species but closely similar among themselves. All three occur natively in the USA, though the latter is primarily a species of Mexico and Central America. *Verbena urticifolia* var. *leiocarpa* is treated here as an intergradient populational variant of *V. urticifolia*. *Verbena carolina* L. is lectotypified here by an illustration in Hortus Elthamensis and epitypified from the Dillenian herbarium—these types were said to be from plants grown from seeds collected in the Carolinas (eastern USA), but their traditional identification as the Mexican species is confirmed here. *Verbena ehrenbergiana* is a closely related species endemic to Mexico and is treated here (including a neotypification) to complete the group. Other type information, descriptions, and a key are provided.

KEY WORDS: *Verbena urticifolia*, *V. scabra*, *V. carolina*, *V. ehrenbergiana*, Verbenaceae

Verbena urticifolia L. and close relatives *V. scabra* Vahl (mainly of the USA) and *V. carolina* L. (mainly of Mexico, but reaching the southwestern USA) have long been recognized as distinct but closely similar species. Aspects of their variability and nomenclature are clarified here in connection with preparation of the FNA treatment of *Verbena*. *Verbena ehrenbergiana* Schauer, restricted to Mexico, is closely related to the three species above and treated here to complete the group.

VERBENA URTICIFOLIA L., Sp. Pl. 1: 20. 1753. **TYPE**: "Habitat in Virginiae, Canadae, *aridis*." **LECTOTYPE** (Méndez Santos & Cafferty 2001, p. 1140): **USA**. Specimen in Linnaean Herbarium, no collection data (LINN 35.13 digital image!). From among several elements of the extant original material for the name, the LINN specimen was chosen as lectotype because it is "the most complete." LINN 35.17 (digital image!), with the notation "Carolina," also appears to be *V. urticifolia* (with subpetiolate leaves).

Verbena diffusa Poir. in Lam., Encycl. 8: 550. 1809. **TYPE**: "Cette plante est cultivee au Jardin des Plantes de Paris; elle croît dans l'Amerique septentionale. (V.s. in herb. Desfont.)." Specimen in Desfontaines Herbarium (holotype: P?). Not listed as such in the fiche catalogue for the Desfontaines Herbarium.

Poiret also described *Verbena diffusa* var. β (also from a specimen in the Desfontaines herbarium), with stems hirsute and spikes erect and scarcely diffuse.

Moldenke (1965a, p. 336) noted that the description of the flowers of *Verbena diffusa* as 'somewhat purple' led him to suspect that *V. diffusa* might be the same entity as *V.* x *engelmannii* Moldenke (= *V. urticifolia* x *V. hastata*).

Verbena incarnata Raf., Atl. J. 154. 1832. *Verbena urticifolia* var. *incarnata* (Raf.) Moldenke, Phytologia 7: 259. 1960. *Verbena urticifolia* forma *incarnata* (Raf.) Moldenke, Phytologia 52: 232. 1982. **TYPE**: USA. Pennsylvania. [Huntingdon, Mifflin, Juniata, or Perry Co.:]: along the Juniata River, *C.S. Rafinesque s.n.* (not located). Moldenke made the transfers to variety and forma without comment.

Verbena urticifolia var. *simplex* Farwell, Pap. Michigan Acad. Sci. 3: 103. 1924. *Verbena urticifolia* forma *simplex* (Farw.) Moldenke, Phytologia 44: 134. 1979. **SYNTYPES: USA.** Michigan. [Oakland Co.]: In woods near Lakeville, 11 Oct 1922, *Billington, Farwell, and Gladewitz 6443* (BLH?, not seen); [Oakland/Wayne Co.]: Northville, *O.A. Farwell 6463* (BLH?, not seen). **LECTOTYPE** (O'Leary et al. 2010): *Farwell 6443* (BLH). Moldenke's transfer of var. *simplex* to the rank of forma was made without comment.

Verbena urticifolia var. *leiocarpa* Perry & Fernald, Rhodora 38: 441, plate 450, figs. 5-8. 1936. **TYPE: USA.** Virginia. Princess Anne Co.: Virginia Beach, rich woods, 10 Sep 1935, *M.L. Fernald, B. Long, and J.M. Fogg Jr. 5013* (holotype: GH digital image!).

Verbena curtisii Moldenke, Phytologia 2: 147. 1946. **TYPE: USA.** North Carolina. "E. Carolina, not date, *M.A. Curtis s.n.* (holotype: GB, herb. G. Geete 5702, LL-photo!). O'Leary et al. (2010) place *V. curtisii* as a synonym of *V. carolina* L.

Plants perennial, fibrous-rooted or sometimes obscurely taprooted. **Stems** erect, 50–150(–250) cm, sparsely to moderately hirsute to hirsutulous or pilose-hirsute, eglandular. **Leaves** ovate to lanceolate-ovate, broadly lanceolate, or oblong-ovate in outline, midstem blades 8–15(–20) cm, margins coarsely serrate to crenate-serrate, hirsutulous or hirtellous to hirsute or strigose-hirsute on both surfaces, eglandular, veins not impressed adaxially; petioles 5–25(–40) mm. **Fruiting spikes** in panicles, elongate and slender with distantly remote fruits, 5–22 cm, bracts; floral bracts ovate-acuminate, 0.5–2 mm, 1/2–2/3 as long as the calyx. **Calyces** 1.5–2.3 mm, strigillose to strigillose-hirsutulous, eglandular, lobes deltate to shallowly deltate-apiculate, incurved by not connivent to subconnivent. **Corollas** white, rarely pinkish, tubes 1.6–2.2 mm, 0.2–0.5 mm longer than the calyx, limbs 1.5–2 mm in diam. **Nutlets** separating at maturity, 1.5–2 mm, commissural faces extending to very tip of nutlets, smooth or rarely with slight development of minutely bullate ornamentation, outer surfaces smooth to shallowly longitudinally ridged, sometimes with cross-ridges distally. $2n = 14$.

Flowering Jun–Oct. Wet woodlands, wet thickets, woods borders, pastures, stream banks, marshy shores, floodplains, shell mounds, ditches, swales, roadsides, fencerows, fields, disturbed sites; ca. 20–1000 m; Man., N.B., Ont., Que., Sask.; Ala., Ark., Conn., Del., D.C., Fla., Ga., Ind., Iowa, Kans., Ky., La., Maine, Md., Mass., Mich., Minn., Miss., Mo., Nebr., N.H., N.J., N.Y., N.C., Ohio, Okla., Pa., R.I., S.C., S.Dak., Tenn., Tex., Va., Vt., Wisc., W.Va.

Verbena urticifolia var. *leiocarpa* has been recognized as a distinct entity in various floristic treatments (e.g., Fernald 1950; Gleason & Cronquist 1991; Magee & Ahles 1999; Rhoads & Block 2007) but simply as a synonym within *V. urticifolia* by others (e.g., Radford et al. 1970; Wunderlin & Hansen 2008). Cooperrider (1995) found no Ohio plants to identify as var. *leiocarpa*, noting however that "there is a considerable amount of variation within Ohio specimens and some may approach var. *leiocarpa*." Moldenke (1965b) recognized var. *leiocarpa* as distinct and apparently continued to do so, since he later reduced other infraspecific taxa to the rank of forma (see typification and nomenclature above). The PLANTS Database (USDA-NRCS 2010) characterizes the two taxa as broadly sympatric over most of the eastern and central USA.

Contrasts between the typical expression of *Verbena urticifolia* and var. *leiocarpa* and have used terminology as in the summary here, mostly following the initial characterizations in the protologue of var. *leiocarpa*.

1. Leaves strigose to strigose-hirsute on abaxial veins, with hairs up to 1–1.3 mm; flowering branches thicker, usually stiffly ascending, strigose, fruits remote, mature calyx 2–2.3 mm, strigose, floral bracts 1–1.5 mm; nutlets 2 mm, corrugated on the back ..... **Verbena urticifolia** var. **urticifolia**

1. Leaves velutinous to subvelutinous abaxially, with hairs 0.3 mm; flowering branches filiform, loosely ascending or divergent, puberulent, fruits distantly remote, mature calyx 1.7–2 mm, puberulent, floral bracts 0.5–1 mm; nutlets 1.5 mm, plane on the back ..... **Verbena urticifolia** var. **leiocarpa**

In my survey of *Verbena urticifolia*, two extremes of adaxial leaf vestiture can be recognized, corresponding to the illustrations in Fernald (1936), but intergradation between them appears to be complete. Several "nodes" can be recognized in the array of variability: (a) strigose to strigose-hirsute along veins; (b) strigose to strigose-hirsute along veins and lamina; (c) strigose to strigose-hirsute along veins and lamina, with a hirsutulous to hirtellous understory of mostly shorter hairs; and (d) softly hirsutulous to hirtellous on veins and lamina, without the strigose to strigose-hirsute vestiture of longer hairs. Fernald's "velutinous to subvelutinous" corresponds to what is here termed "softly hirsutulous to hirtellous," but they clearly refer to the same state, characterizing var. *leiocarpa*. This variability in vestiture (including the "leiocarpa" variants) is confirmed here to occur essentially throughout the range of the species, from the Atlantic coast westward to Texas and Kansas. I cannot find correlations between any 'node' of the leaf vestiture and any of calyx length or calyx vestiture, spike morphology or spike vestiture, floral bract length, or nutlet size or morphology.

The identity of *Verbena carolina*.

Verbena carolina of Linnaeus in 1759 was based explicitly on an illustration and description by Jacob Dillenius in Hortus Elthamensis in 1732 and identified as "Verbena carolinensis, melissae folio aspero." The protologue referred or alluded to no other plant, except indirectly, through Dillenius's description (see below). Dillenius noted that the plant was grown from seeds collected in the Carolinas ("orta e seminibus Carolinensibus").

The plant illustrated by Dillenius has hirsute stems, subsessile to short-petiolate cauline leaves, and relatively few, compact, and short spikes from distal axils. The spikes apparently are in early development, not lengthened at maturity with widely remote fruits. In addition to the diagnostic "folio aspero" in the Dillenian phrase name, the extended description by Dillenius noted hirsute stems ("caulibus … hirsutis") and leaves rough to the touch ("tactu asperis"). At the end of his description, Dillenius included an entry in John Ray's *Historia plantarum generalis* (H.S. Pet. Raj. Hist. Plant. Tom. III. App. p. 249. num. 10: "10. Verbena *Carolmiana* fol. integro serrato scabro."

Two specimens in the Dillenian Herbarium (images and observations provided by OXF Curator Stephen Harris) are particularly relevant to the consideration here.

Hort-301-388a (Fig. 1) has three plants of the same species. The left plant is labelled by Sherard "carolina ex H. Elth. 1726." The middle plant is labeled (bottom left) in the handwriting of Dillenius: "Verbena Carolin. Melissa folio aspero H. Elth. Verbena Carol. folio integro serrata scabro. Pet. H.S. 10 Raj. Hist. III. App. 249. Eltham 1726" with the number "24." This plant is a very close match for the Dillenius illustration, plausibly even the one used for it (compare Figs. 1 and 2). The right plant is labeled (neither Sherard nor Dillenius) "Verbena carolina Sp. Pl. 29. 12. Feb." (a reference to the entry for *V. carolina* in Species Plantarum ed. 2, 1: 29. 1762, no. 12). Pencilled on the sheet by Asa Gray, above the right label, is "V. polystachya HBK."

Hort-301-388b has a single plant, with two labels in Sherard's handwriting. One label notes "Eltham 1727. … Mexico I think." The other label has "Verbena integrifol. spicis tenuissimis, floribus minimis albus, ~~Mexico~~ (the "Mexico" crossed through).

Despite attestations in the protologue (including the epithet and the illustration) and on the specimens that the plants originated from the Carolinas, both the illustration and associated specimens represent the Mexican species, not *V. urticifolia* or *V. scabra* of the eastern USA.

Seeds from Mexico might have come to Sherard from William Houstoun (1695-1733). According to Clokie (1964), Sherard grew seeds from Houstoun at Eltham, and Houstoun is represented by specimens in the OXF Herbarium. His travels in Mexico (Veracruz and Campeche),

however, apparently were between 1729 and 1733, thus he probably was not the collector of the Dillenian specimens labeled with the years 1726 and 1727. Stephen Harris (pers. comm. Feb 2010) noted that "One can imagine numerous scenarios that might explain Sherard's confusion [about the provenance]. There are other examples in the Sherard Herbarium where Sherard has crossed out localities and changed his mind."

It seems almost certain, though, that Sherard's crossed-out notations of "Mexico" on 301-388b were indeed connected with the real provenance of the plants. Asa Gray's annotation indicates that he identified them as Mexican in origin, and in the Synoptical Flora (Gray 1878), in synonymy of *Verbena polystachya*, he noted "*V. Caroliniensis*, Dill. Elth. ii. 407, t. 301, fig. 388: therefore *V. Carolina*, L. Spec. ed. 2, ii. 29, but not in Carolina," again indicating that he perceived the mismatch between the name (and the intended provenance) and the Sherardian specimens and illustration.

VERBENA CAROLINA L., Syst. Nat. ed. 10, 2: 852. 1759. **LECTOTYPE**: (designated here): [icon] in Dillenius, Hort. Eltham. 2: 407, plate 407, fig. 388. 1732. Fig. 1. Protologue of 1759: "V. tetrandra, spic. filiformibus, fol. indivisis, lanceolatis serratis obtusiusculis subsessilibus. Dill. elth. t. 301. f. 388." In 1762 (Sp. Pl. ed. 2, 1: 29), Linnaeus included a reference to the Petiver specimen in Ray's Historia plantarum. **EPITYPE** (designated here): middle plant of Hort-301-388a, labeled by Dillenius as "Verbena Carolin. Melissa folio aspero H. Elth.," Eltham, 1726 (Dillenian Herbarium, OXF digital image!, Fig. 2).

Verbena caroliniana L. (Syst. Veg. ed. 13, 62. 1774) is an orthographical variant of *Verbena carolina* L. Similarly, Willdenow (Sp. Pl. ed. 4, 1(1): 119. 1797) used the epithet "caroliniana," repeating Linnaeus's original description of *V. carolina* and referring to the Dillenius illustration. Sprengel (Syst. Veg. 2: 748. 1825) also used "caroliniana" as the epithet, citing "Carolina, Mexico. (V. 2serrata Kunth)." *Verbena carolinensis* (Walter) Gmelin ex Small (Fl. S.E. U.S. 1009. 1903), is a synonym of *Verbena carnea* Medik. (Nesom 2010). Michaux (Fl. Bor.-Amer. 2: 14. 1803) attributed the authorship of his *Verbena caroliniana* to Linnaeus, but his description and type specimen refer to *Verbena carnea*.

Verbena polystachya Kunth, Nov. Gen. Sp. (qto.) 2: 274. 1818. *Verbena* [*caroliniana*] var. *polystachya* (Kunth) Loes., Fedde Repert. Sp. Nov. Veg. 9: 687. 1846. **TYPE**: **Mexico**. [Michoacan]. Jorullo, "Crescit in devexis montis ignivomi Xorullo, alt. 600 hex. (Regno Novae Hispaniae)," *A. von Humboldt and A.J.A. Bonpland s.n.* (holotype: P fiche!). Kunth noted "Verbenae urticaefoliae Linn. proxima."

Verbena biserrata Kunth, Nov. Gen. Sp. (qto.) 2: 275. 1818. **TYPE**: **Mexico**. [Edo. Mexico]. "Crescit prope urbem Mexici," *Humboldt and Bonpland s.n.* (P fiche!, photo-MO!). Kunth noted "A Verbenae urticaefoliae vix distinguitur, nisi foliis oblongis serratis, dentibus alternis minoribus."

Verbena veronicifolia Kunth, Nov. Gen. Sp. (qto.) 2: 274. 1818 [non J.E. Smith, Cycl. 36: 28. 1817]. **TYPE**: **Mexico**. [Hidalgo]. "Crescit prope Moran Mexicanorum, alt. 1426 hex," *Humboldt and Bonpland 4065* (holotype: P fiche!).

Verbena hirsuta Mart. & Gal., Bull. Acad. Roy. Sci. Bruxelles 11: 321. 1844. *Verbena carolina* var. *hirsuta* (Mart. & Gal.) Moldenke, Phytologia 44: 473. 1979. *Verbena carolina* forma *hirsuta* (Mart. & Gal.) Moldenke, Phytologia 47: 330. 1981. **SYNTYPES**: **Mexico**. Veracruz. Jalapa, Jun-Oct 1840, *H.G. Galeotti 735* (BR, photo-US, photo-F, photo-NY, K fide Perry 1933); Mirador, *H.G. Galeotti 790* (BR). **LECTOTYPE** (O'Leary et al. 2010): *Galeotti 735* (BR). Moldenke (1963) placed *V. hirsuta* as a synonym of *V. carolina* forma *albiflora* (= *V. menthifolia*).

Verbena mollis Mart. & Gal., Bull. Acad. Roy. Sci. Bruxelles 11: 323. 1844 (non Raf., Atlantic J., 146. 1832). **TYPE**: **Mexico**. Oaxaca. *H.G. Galeotti 737* (holotype: BR). Fide Moldenke (1963a) and from the description. O'Leary et al. (2010) also place it here.

Verbena pauciflora Mart. & Gal., Bull. Acad. Roy. Sci. Bruxelles 11: 324. 1844 [non Turcz. 1863]. **TYPE**: **Mexico**. Veracruz. Mirador, *H.G. Galeotti 773* (holotype: BR). Fide Moldenke (1963a) and from the description. O'Leary et al. (2010) also place it here.

Plants annual to short-lived perennial herbs, fibrous-rooted. **Stems** 1–5 from the base, erect, 30–100 cm, glabrate to sparsely or moderately hirsute or hirsute-villous, with spreading to upturned, often flattened hairs, eglandular. **Leaves** narrowly elliptic to elliptic-lanceolate or lanceolate, midstem blades 3–8 cm x 8–25(–30) cm, veins not impressed adaxially, margins serrate to serrate-crenate, strigillose to hirsute-strigose adaxially, hirsute to hirsutulous abaxially, eglandular; petioles 3–7 mm. **Fruiting spikes** 5–20 in panicles, elongate and slender with distantly remote fruits, 5–35 cm; floral bracts ovate-triangular to triangular, 0.8–1.2 mm, shorter than the calyces. **Calyces** 1.5–2 mm, hispid-strigose to hirsute-strigose, eglandular, lobes triangular, connivent. **Corollas** lilac to lavender or blue, rarely white, tubes 2.2–2.5 mm, 0.2–0.8 mm longer than the calyces, limbs 1.5–2.5 mm in diam. **Nutlets** adherent until late in ontogeny or weathering, (1.2–)1.5–2 mm, commissural faces extending to very tip of nutlets, smooth, outer surfaces weakly longitudinally ridged, rarely smooth, sometimes with cross-ridges distally. $2n = 14$.

Flowering mostly Aug–Oct. Creek banks, springs, canal banks, canyon bottoms, flood plains, riparian woods, rocky slopes; in the USA at (400–)800–1900 m, in Mexico at (140–)1800–2400(–3000) m; Ariz. (Cochise, Gila, Maricopa, Pima, Santa Cruz cos.); Mexico (Chiapas, Chihuahua, Colima, Durango, Guanajuato, Guerrero, Hidalgo, Jalisco, Edo. México, Michoacan, Morelos, Nayarit, Nuevo León, Oaxaca, Puebla, Querétaro, Sinaloa, Sonora, Tamaulipas, Veracruz, Zacatecas), Central America (El Salvador, Guatemala, Honduras, Nicaragua).

Verbena carolina is distinct in aspect, compared to *V. urticifolia*, especially because of its smaller, subpetiolate leaves. The species is at the northernmost point of its range in southern Arizona (Cochise, Gila, Maricopa, Pima, and Santa Cruz cos.). A collection from Nevada ([Douglas Co.]: Carson Valley, Aug 1872, *Lemmon 3075*, GH-as cited by Perry 1933) has not been verified here, but this locality is far out of range for the species; at least *V. carolina* has not been subsequently observed in Nevada, and it does not appear to be a member of that state's flora.

The calyces of some plants of *Verbena carolina* are very urticifolia-like, slightly exposing the nutlet apices, but the leaves and fruits are characteristic of the species, e.g., **Nayarit**. 3-4 mi S of Ahuacatlán, 18 Nov 1961, *Gentry et al. 19536* (ARIZ); **Sonora**. El Capitan, 25 Aug 1986, *Martin et al. s.n.* (ARIZ).

The identification by O'Leary et al. (2010) of *Verbena curtisii* Moldenke (here = *V. urticifolia*) as a synonym of *V. carolina* places the latter in the eastern USA; their synonymization of *V. sedula* (a good species) under *V. carolina* places the latter in the Galapagos Islands; their synonymization of *V. litoralis* forma *magnifica* Moldenke (= *V. litoralis*, Nesom 2010x) under *V. carolina* places the latter in Ecuador. I have not evidence that *V. carolina* occurs anywhere except in the range given above.

VERBENA SCABRA Vahl, Eclog. Amer. 2: 2. 1798. **TYPE**: "Habitat in America meridionali," [1786], *Dr. v. Rohr no. 35* (holotype: C, IDC microfiche: Vahl no. 78 I, 5!).

Julius von Rohr in 1786 collected on Martinique, Guadeloupe, Barbados, Antigua, Anguilla, the Virgin Islands, Puerto Rico, and Hispaniola (Howard 1975), and the type of *Verbena scabra* presumably is from the West Indies.

Verbena scabra forma *angustifolia* Moldenke, Phytologia 14: 296. 1967. **TYPE**: **USA**. Texas. Burnet Co.: moist black loam at edge of Beaver Creek, 21 Jul 1966, *J.R. Crutchfield 1837* (holotype: LL! digital image!).

Verbena scabra forma *ternifolia* Moldenke, Phytologia 29: 503. 1975. **TYPE**: **USA**. Texas. Burnet Co.: Dove Creek on the Tweedy Ranch at Knickerbocker, creek riparian, 19 Jul 1974, *R. Eckhardt 1739* (holotype: LL! digital image!).

Plants annual to short-lived perennial herbs, fibrous-rooted, sometimes appearing rhizomatous. **Stems** usually 1 from the base, erect, (50–)70–170 cm, moderately to densely hispidulous to hispid-hirsute, hirsute, or hirsute-strigose, eglandular **Leaves** ovate-lanceolate to ovate-elliptic or lanceolate, midstem blades (3–)5–12 cm x 15–60 mm, margins evenly serrate, scabrous or hispidulous to hispid or hispid-hirsute adaxially, hispid to hirsute-strigose abaxially, eglandular, veins not impressed adaxially; petioles 5–15(–30) mm, narrowly winged or nearly indistinct. **Fruiting spikes** 3–7(–15) in panicles, elongate and slender with distantly remote fruits, 5–40 cm; floral bracts ovate-lanceolate to triangular or narrowly triangular, 1–1.5 mm, shorter than the calyces. **Calyces** 1.5–2.5 mm, hispidulous to hispid-strigose or hirtellous with upturned hairs, eglandular, lobes lanceolate to triangular, connivent. **Corollas** pinkish to bluish, lavender, or purple, tubes 1.5–1.7 mm, 0.2–0.5 mm longer than the calyces, limbs 1.4–2.2 mm in diam. **Nutlets** separating at maturity, 1–1.5 mm, commissural faces extending to very tip of nutlets, consistently silvery white densely papillate-bullate, outer surfaces deeply ridged and grooved, often with prominent cross-ridges. $2n$ = unknown.

Flowering (Apr–)Jun–Sep. Low woods, open slash pine woods, marshy shores, wet thickets, floodplains, stream banks, shell mounds, back dunes and flats, swales, ditches, sandy fields, disturbed sites; 10–100 m; in the western USA—canyons, marshes, river and pond edges, 300–2100 m; Ala., Ariz., Calif., Fla., Ga., La., Md., Miss., N.Mex., N.C., S.C. Tex., Va., W.Va.; Mexico (Baja California, Chihuahua, Coahuila, Sonora), Bermuda, Bahamas, West Indies (Cuba, Hispaniola, Jamaica, Puerto Rico).

Verbena scabra in the USA mostly occurs in marshy habitats near the Atlantic and Gulf coasts. In inland localities and its range across Texas westward to California (apparently adventive?), it usually grows in wet places. The species was attributed to Arkansas by Moldenke (1964; Drew Co.: *Demaree 13696*, SMU!; *Demaree 24748*, BM, SMU!), but these are identified here as *V. urticifolia*. Similar observations by Smith (1988) and Brent Baker (pers. comm. 2010)—Arkansas plants previously identified as *V. scabra* actually are *V. urticifolia*—preceded mine. The other Arkansas collection cited by Moldenke, however, is indeed *V. scabra*: Washington Co.: Fayetteville, 29 Jul 1927, collector not specified but handwriting on an original ("Herbarium of the University of Texas" label is possibly that of B.C. Tharp? (TEX). Given the dubious circumstances of the label and lack of other evidence that *V. scabra* occurs in the state, it is not considered here to be a member of the Arkansas flora.

Verbena scabra usually is distinct from *V. urticifolia* in scabrous or hispidulous to hispid leaf vestiture, but plants of *V. scabra* sometimes (rarely) develop slightly longer hairs and the vestiture becomes nearly hirsute, approaching *V. urticifolia*. More commonly, leaves of *V. urticifolia* may develop near-hispid vestiture approaching that of *V. scabra*. In such cases, other features can be used to distinguish them, as in the key below. The differences in calyx morphology and petiole elaboration are the most consistent. I have not seen an unequivocal intermediate between the two species, but given the ease with which vervains hybridize and the probable difficulty in detecting a hybrid between these two, it's not unlikely that they are formed.

Verbena scabra has sometimes been described as rhizomatous (e.g., Radford et al. 1970; *Wright & Baker 1683*, ASU, from Pinal Co., Arizona). The plants most commonly are collected as shallowly fibrous-rooted annuals or short-lived perennial, occasionally developing a taproot, but the basal portions of the stems sometimes apparently are procumbent and rhizome-like, layering and producing adventitious roots. I have seen examples of such from Alabama, California, Florida, Louisiana, Mississippi, and South Carolina, and from Hispaniola. One collection from Baja

California (Santo Tomás, 15 Jul 1885, *Orcutt 1302*, MO) bears a plant with fibrous roots, clearly annual in duration; the plant of a duplicate sheet (MO) has a layered, "rhizomatous" portion 12 cm long. Other collections are unequivocally rhizomatous (vs. procumbent and layering): **Bahamas**. Eleuthera, 16 Aug 1977, *Correll 48999* (MO). **USA**. **Arizona**, Gila Co., 20 mi N of Rice, 4 Oct 1927, Harrison 4897 (ARIZ); Yavapai Co., Page Spring State Fish Hatchery, along edge of stream, 17 Aug 1966, *Crutchfield 1966* (LL); **California**, Los Angeles Co., Verdugo Canyon, 11 Aug 1910, *Blake 676* (LL); **New Mexico**, Eddy Co., seeping area near Rattlesnake Spring, 9 mi SW of White City, 26 Oct 1966, *Crutchfield 2407* (LL); **Virginia**, Isle of Wight Co., 27-29 1940, *Fernald & Long 12785* (TEX). **Mexico**. **Coahuila**, 1.5 mi W of Ocampo at "Parque La Mota," along stream, 1150 m, 25 Sep 1998, *Henrickson 20511* (TEX); Sierra de San Antonio, canyon San Antonio de los Alamos, moist ground in shaded canyon, 2-3 Sep 1940, *Johnston & Muller 877* (TEX). Some collections are of plants with leaf-tipped basal "offsets" (Jamaica, Dec 1890, *Hitchcock s.n.*, MO, offsets 12 cm long; Jamaica, 9 Jun 1963, *Proctor 23622* (LL), offsets 3 cm long; California, 19 Aug 1910, *Blake 788* (LL), offsets 8 cm long; Virginia, 20 Oct 1936, *Fernald & Long 6863*, MO, offsets 4–5 cm long).

VERBENA EHRENBERGIANA S. Schauer, Linnaea 20: 477. 1847. **SYNTYPES**: **México**. Protologue: "In Mexico, pr. los Reyes, C. Ehrenberg 517 et 713." [Edo. México]. Barranca prope los Reyes, [probably 1832, fide Urban 1897], *C. Ehrenberg 713* (B-s.n. photo-MO!, plant on right; B-17414 photo-F!, photo-MO!, photo-TEX!). Moldenke (1963b) noted that *713* is the type but did not mention that is it one of two syntypes. The B specimens are no longer extant, thus a widely distributed **NEOTYPE** is designated here: **Mexico**. Moist places near Monterrey, Jul 1888, *C.G. Pringle 1948* (MO!; isoneotypes: BR, F, GH, MEXU, MICH, NY, PH, S, UC, US, VT). Duplicates as cited by Perry (1933) and Moldenke (1963b). A neotype to be designated by O'Leary et al. (2010), said to be an Ehrenberg collection (P: "*C. Ehrenberg 153*," from Wartenberg in Veracruz) was instead collected by Louis C. Ervendberg, who collected plants in that region for Asa Gray from early 1857 to late 1860.

Verbena ehrenbergii var. *richardsonii* Moldenke, Phytologia 38: 499. 1978. **TYPE**: **México**. Tamaulipas. Gómez Farias area, Rancho del Cielo, bird census area, near ranch, 29 May 1969, *A. Richardson 1234* (holotype: LL! digital image!; isotype: LL! digital image!). O'Leary et al. (2010) place var. *richardsonii* as a synonym of *V. carolina* L.

Plants perennial herbs, taprooted or fibrous-rooted, sometimes appearing rhizomatous. **Stems** mostly 1 from the base, erect, 50–100 cm, hirsute, hirsute-pilose, or most often bristly-pilose, eglandular. **Leaves** ovate to narrowly ovate or lanceolate to oblong-lanceolate, basal not persistent, midstem cauline 2–7 cm x (8–)10–30 mm, margins coarsely serrate to crenate-serrate, usually with a distinct pair of narrow lobes near the base, sparsely hirsute to strigose-hirsute or strigose adaxially, hirsute abaxially mostly along the veins, eglandular, usually with a petiole or petiolar region 5–15 mm. **Spikes** (3–)5–25(–40) from distal branches, elongate and slender with distantly remote fruits, 4–18 cm; floral bracts ovate-lanceolate, 1–1.5 mm, shorter than the calyces. **Calyces** 1.5–2.1 mm, hirsute-strigose to loosely strigose, eglandular, lobes subulate, incurved. **Corollas** white (pale lilace or blue in Querétaro), tubes 1.7–2 mm, 0.1–0.5 mm longer than the calyx, limbs 1–2 mm in diam. **Nutlets** 1–1.5 mm, separating tardily, commissural faces reaching the tip, bare. $2n = 14$.

Flowering (Apr–)May–Aug(–Oct). Road banks, river beds, moist places, rocky hills, thorn scrub, cloud forest; (40–)100–2000 m. Mexico (Coahuila, Hidalgo, Nuevo León, Puebla, Querétaro, San Luis Potosí, Tamaulipas, Veracruz).

Verbena ehrenbergiana has been attributed to Arizona based on a specimen at TEX collected in "Arizona" without definite locality (Kearney & Peebles 1961; *Stalmach 198*, TEX, as cited by Moldenke 1963b), but this locality is far out of range for the species. It has never been otherwise reported from the USA and is not considered here to be a member of the Arizona flora.

Verbena ehrenbergiana is distinct among its closest relatives in its consistently 3-lobed leaves and bristly stem vestiture. The calyx lobes are deltate-triangular and slightly connivent but not as long as those of *V. scabra*. It apparently is restricted to northeastern Mexico—I have not seen collections cited by Moldenke (1963b) from Distrito Federal ("*Arsene 8829* in part," B) and Michoacan ("*Arsene 8829* in part," NY), but the species has not otherwise been reported from that area. It was not included in the treatment for the Valley of Mexico (Peralta 1985).

The types of *Verbena ehrenbergiana* var. *richardsonii* have coarsely toothed leaves without the typical pair of basal lobes, but in other features (the deltate calyx lobe and bristly-pilose stems) they clearly belong with *V. ehrenbergiana*. Collections from the Rancho del Cielo area are the only ones observed over the range of the species without the basal lobes, but the Rancho del Cielo plants are variable in basal lobing—some others also are unlobed (*Richardson 216*, *293*, and *Sullivan 554*), while the rest are typically lobed.

Additional specimens examined and cited (herbaria without exclamation points are from Perry (1933), Moldenke (1963b), and Nash and Nee (1984)). **Coahuila**. El Bajío, Buenavista, Saltillo, area cercanes al arroyo y cultivos, 1850 m, 12 Oct 1980, *Carranza & Villarreal 1401* (ARIZ!). **Hidalgo**. Along Hwy 85 between Tamazunchale and Jacala, 37 mi SW of Tamazunchale near Palomas, cloud forest on steep roadbanks, 1500 m, 25 Jun 1977, *Croat 39305* (MO!) and *Croat 39343* (MO!); Jacala, 12 Aug 1937, *Edwards 757* (MO!, TEX!); Jacala, 4800 ft, 12 Aug 1937, *Fisher 46169* (MO!, US); 12 mi up mine road W of Mex 85, 2 mi N of Posada de Rey, Zimapan, 5 Jul 1966, *Mears 299a* (TEX!). **Nuevo León**. 21.2 mi N of Montemorelos, out of Margarita, Hwy 85 between Monterrey and Montemorelos, thorn scrub community, 9 Aug 1972, *Dziekanowski et al. 1712* (MO!); Mpio. Iturbide, below San Pedro Iturbide, IRF Iturbide, 1070 m, 25 Sep 1979, *Hinton 17609* (TEX!); Mpio. Iturbide, Iturbide –>Camarones, oak and pine woods, 1580 m, 9 Jun 1991, *Hinton 21398* (TEX!); Mpio. Aramberri, Cerro El Viejo, pine forest, 1255 m, 2 Oct 1993, *Hinton 23827* (TEX!); Monterrey, 21 Jul 1933, *Mueller 156* (TEX!); wooded waterway below Alamar, ca. 15 mi SW of Galeana, dense woods, 21 Jun 1934, *Mueller 1132* (TEX!); Mpio. Zaragoza, ca. 3-7 mi ESE of Zaragoza, SW side of Cerro Viejo peak, oak-pine woods, 2000 m, 22 Sep 1993, *Nesom 7725* (TEX!); Mpio. Galeana, Hacienda Pablillo, 26 Aug 1936, *Taylor 238* (MO!, TEX!). **Puebla**. Pahuatlan, 12 Jul 1913, *Salazar s.n.* (MEXU, US). **Queretaro**. Mpio. Pinal de Amoles, Ahuacatlán, 1400 m, 24 Dec 1982, *Hernandez M. 9287* (TEX!); Pinal de Amoles, bosque de *Pinus patula*, 2600 m, 10 Mar 1978, *Zamudio 2675* (TEX!). **San Luis Potosí**. Mpio. San Antonio, Between Tanjasnec and San Pedro, 26 Oct 1978, *Alcorn 2066* (TEX!). **Tamaulipas**. Mpio. de Gomez Farías, region of Sierra de Guatemala, at and slightly above Aguacates junction, ca. 5 km WNW of Gomez Farías, ca. 600 m, 19-25 Aug 1984, *Johnston 12801* (TEX!); Victoria, 16 Oct 1937, *Kenoyer s.n.* (MO!); Mpio. de Gomez Farías: Rancho del Cielo: between red gate and ranch, 20 Jun 1968, *Richardson 188* (LL); between gate and ranch, 20 Jun 1968, *Richardson 216* (LL); Cathedral Cave, near ranch, 24 Jun 1968, *Richardson 293* (LL); road near ranch, 28 Dec 1968, *Richardson 1116* (LL); 27 km SE of Miquihuana on road to Palmillas, broad damp river bed, 2025 m, 13 Aug 1941, *Stanford et al. 891* (ARIZ!, MO!, DS, NY, WTU); Mpio. de Gomez Farías: Sierra de Guatemala, San Pablo, and just below San Pablo on road toward Gomez Farías, 3500 ft, oak-sweetgum, 10 Jun 1971, *Sullivan 409* (TEX!); W of San Pablo toward Indian Springs, 3500 ft, 16 Jun 1971, *Sullivan 475* (TEX!); Sierra de Guatemala, between Old Company Clearing (4000 ft) and the Malacati turnoff (4200 ft) on road between Rancho del Cielo and Julilo, humid oak-sweetgum forest on limestone, 22 Jun 1971, *Sullivan 554* (TEX!). **San Luis Potosí**. Río Verde, 17 Nov 1910, *Orcutt 5423* (MO!); Minas de San Rafael, Bagre, Jul 1911, *Purpus 5451* (F, GH, MO!, NY, US). **Veracruz**. No collection data [near Tantoyuca], *Ervendberg 153* (GH); Misantla, Santa Cruz de Hidalgo, carretera Misantla-Martinez de la Torre, selva mediana subperennifolia, secundaria, zona cafetalera, 140 m, 26 Apr 1976, *Hernandez et al. 154* (F, MEXU, MO!, NY, XAL).

Key to the species of the *Verbena urticifolia* group

1. Leaves 3-lobed ..... **Verbena ehrenbergiana**
1. Leaves not lobed.

2. Leaves mostly sessile to subpetiolate; adaxial leaf surfaces strigillose to hirsute-strigose; calyx tapering distally to lanceolate to triangular lobes, connivent; corollas lilac to lavender, rarely white, tubes 2.2–2.5 mm ..... **Verbena carolina**
2. Leaves mostly petiolate; adaxial leaf surfaces either densely scabrous or sparsely pilose to glabrous to glabrate; calyx lobes lanceolate to triangular and connivent or deltate and not connivent; corollas either mostly white or blue to purple, tubes 1.5–2.2 mm.

3. Adaxial leaf surfaces hirsutulous to hirsute or strigose-hirsute; calyx abruptly narrowed distally to deltate to shallowly deltate-apiculate lobes, incurved but not connivent or subconnivent, top of the nutlets exposed; corollas white, rarely pinkish; nutlet outer surfaces smooth to longitudinally ridged, sometimes with cross-ridges distally, commissural faces smooth or rarely with slight development of minutely bullate ornamentation ..... **Verbena urticifolia**
3. Adaxial leaf surfaces densely scabrous or hispidulous to hispid or hispid-hirsute; calyx tapering distally to lanceolate to triangular lobes, connivent, top of nutlets obscured; corollas mostly pinkish to bluish, lavender, or purple; nutlet outer surfaces deeply ridged and longitudinally grooved, often with prominent cross-ridges, commissural faces consistently densely silver-white minutely papillate-bullate ..... **Verbena scabra**

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Figure 1. Illustration by Dillenius in Hortus Elthamensis of "Verbena carolinensis Melissae folio aspero," the lectotype of *Verbena carolina* L. See comments in text.

Figure 2. Specimen from the Dillenian Herbarium (OXF), Hort-301-388a. The middle plant is the epitype for *Verbena carolina* L. See comments in text.

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NEOTYPIFICATION OF *VERBENA CARNEA* (VERBENACEAE)

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ABSTRACT

A neotype is selected for *Verbena carnea* Medikus (from 1784), securing its continued usage as the name for a species of the southeastern USA. The description and type of *Verbena caroliniana* Michx. (from 1803) refer to the same species as *V. carnea*, but the application of *V. caroliniana* has been confused. Michaux's publication cited the authority of the name as Linnaeus, but *Verbena caroliniana* L. (1774) is an orthographical variant of *Verbena carolina* L. (1753), a different species. Similarly, the name *V. caroliniana*, as repeated from Linnaeus by Willdenow (1797) and Sprengel (1825), referred to *V. carolina* L. *Phryma caroliniensis* Walter (from 1788) also refers to the same species but is without a type.

Verbena carnea Medikus (from 1784) has generally been used as the name for a distinctive species of the southeastern USA (e.g., Perry 1933; Small 1933; Fernald 1950; Moldenke 1960, 1970, 1979; Radford et al. 1968; Wunderlin & Hansen 2010). Earlier, Walpers (1845) used *V. caroliniana* Willd., citing in synonymy *V. carnea* Medikus and two others that joined together the concepts of the southeastern USA species and Mexican species. Gray (1878) used *V. caroliniana* Michx. (from 1803) for the USA species. O'Leary et al. (2010) have re-adopted *V. caroliniana* Michx. as the correct name for this species, as preferred over the earlier one by Medikus, reiterating earlier observations by Moldenke that *V. carnea* lacks a type and that its protologue description is ambiguous or insufficient in establishing which species is described. Schauer's early overview of Verbenaceae (1847) referred to this species as "39. V. carnea (Med. fide auct.)" (p. 545), implicitly acknowledging that his application of the name was a continuation of earlier usage; he cited various collections but not one associated with Medikus.

Moldenke (1960, pp. 296) acknowledged that no type for *Verbena carnea* was known and quoted a 1941 letter from J.H. Barnhardt pertinent to the consideration: "I have never heard of any Medicus specimens. He was in charge of the palace garden at Mannheim, and very likely described from living plants. Whether he or the garden had a herbarium, I do not know, but if so it may have been destroyed in the Austrian bombardment of 1796, which nearly wiped out the town. The old-time palace garden was at last accounts a public park; perhaps, after 160 years, the verbenas still grow there! As far as I know, the present-day herbarium nearest (10 miles) to Mannheim is at the University of Heidelberg, and is very little known to taxonomic botanists. If it were not for this war inquiries might locate Medicus specimens there, but that is not likely."

The German protologue by Medikus of *Verbena carnea* was quoted by Moldenke (1960, pp. 296–297), but he did not translate it or discuss any aspect of it (nor, apparently, did Moldenke ever, in any publication, explicitly comment on the justification of adopting the Medikus name). Medikus described nothing but features of floral morphology, noting that the corolla tubes had hairy throats like those of *Verbena*, *Glandularia*, *Priva*, and *Phyla* and apparently describing the bilobed stigma and globose stigmatic area on the abaxial lobe. The flowers were described as flesh-colored ("Die Blume ist fleischfarben")—presumably the basis for the choice of epithet. The stigma morphology

places the species with either *Verbena* or *Glandularia*, but there is nothing in the protologue that would point to or eliminate any species in either genus. I agree that the protologue is completely ambiguous and vague, yet at some point in the early history of the name, it came to be associated with the species under consideration.

Michaux's *Verbena caroliniana* refers to the same species.

The name *Verbena caroliniana* has been confused in usage—with varying applications of that epithet and also with ambiguity in application of the related name *V. carolina*. *Verbena carolina* L., as currently identified, is a separate and distinct species mostly of Mexico and the southwestern USA (Nesom 2010). Linnaeus mistakenly used *Verbena caroliniana* L. (Syst. Veg. ed. 13, 62. 1774) as an orthographical variant of *Verbena carolina* L. Willdenow (Sp. Pl. ed. 4, 1(1): 119. 1797) followed the mistake, using "*Verbena caroliniana*," the orthographical variant, repeating Linnaeus's original description of *V. carolina* and referring to a Dillenius illustration pertinent to the typification of *V. carolina* L. Sprengel (Syst. Veg. 2: 748. 1825) treated "Verbena caroliniana," also clearly describing the Mexican species, citing "Carolina, Mexico. (V. 2serrata Kunth)."

In Michaux's use of the name *Verbena caroliniana*, he specifically attributed the authorship to Linnaeus, but both Michaux's description and the type specimen at P associate the name with the southeastern USA species rather than the primarily Mexican one. This iteration of *Verbena caroliniana* has been taken as validly published, with authorship attributed to Michaux, at least as early as Gray (1878, p. 336) although Gray's entry cited "*V. carnea*, Med. ex Schauer in DC. l.c. 545" in synonymy. In the same account, Gray cited *V. carolina* L. as a synonym of the Mexican *V. polystachya* Kunth.

Walter's *Phryma caroliniensis* is earlier than Michaux's *Verbena caroliniana*.

Even if it is argued that Michaux's *Verbena caroliniana* is securely established by the description and type, the identity of Walter's *Phryma caroliniensis* (= *Verbena caroliniensis*, as transferred by Small, see below) seems unequivocal from the protologue and that name has long been accepted as a synonym of the same species as *V. carnea*. No type is known for *P. caroliniensis* Walter but its neotypification and use would thus precede acceptance of the Michaux name.

The choice.

Which is the best name for the species under consideration? *Verbena caroliniana* Michx. (from 1803) can be considered unambiguously typified, but the epithet brings with it much historical confusion. *Phryma caroliniensis* Walter (= *Verbena caroliniensis* [Walter] J.F. Gmelin ex Small) (from 1788) refers to the same species but is without a type. *Verbena carnea* Medikus (from 1784) is the earliest name but no type is known and the protologue is uninformative, requiring a neotype is required to establish its identity. A choice between these alternatives incorporates a degree of subjectivity, but a neotype for *V. carnea* is designated here, unambiguously establishing it as the correct name.

Verbena carnea Medikus, Bot. Beob. 1783: 131. 1784. *Stylodon carneus* (Medikus) Moldenke, Revista Sudamer. Bot. 5: 2. 1937. Medikus did not cite a type and no type is known. **NEOTYPE** (designated here): USA. Florida. Jefferson Co.: upland open pine-oak woodland, 1.5 mi N of Wacissa, 5 May 1960, *R.K. Godfrey 59506* (NCU; isoneotypes: SMU!, VDB!).

Phryma caroliniensis Walter, Fl. Carol., 166. 1788. *Verbena caroliniensis* (Walter) J.F. Gmelin ex Small, Fl. S.E. U.S. 1009. 1903. *Stylodon carolinense* (Walter) Small, Man. S.E. Fl., 1135, 1508. 1933. *Leptostachya caroliniensis* (Walter) Kuntze Revis. Gen. Pl. 2: 508. 1891. **TYPE: USA.** South Carolina, presumably, but Walter did not cite a specimen and no type is known (Dan Ward, pers. comm. 2010). The protologue: "foliis sessilibus obovato-oblongis, serratis, scabris, spica terminali."

Verbena caroliniana Michx., Fl. Bor.-Amer. 2: 14. 1803. **TYPE: USA.** "Hab. in Carolina," no date, *A. Michaux s.n.* (holotype: P fiche!). The entry for this species is "V. CAROLINIANA L. V. erecta: foliis oblongo-obovalibus, obtusis: spicis filiformibus, longissimus, distinctifloris. OBS. Corolla dilute rubens. HAB. in Carolina."

Stylodon scabrum Rafinesque, Neogenyton, 2. 1825. **TYPE: USA.** Publication not seen. The name is indicated to be a "nom. illeg." by Wunderlin and Hansen (2010).

Styleurodon caroliniamum Rafinesque, Fl. Tellur. 2: 104. 1837 [1836]. **TYPE: USA.** Not known. Protologue: "395. *Styleurodon caroliniamum*, Raf. Verbena do L. Phryma do Walt. Scabro erecto, fol. cuneatis oblongis ineq. serratis, spicis filiformis.—From Carolina to Florida and Alabama, seen alive. Very near *Verb. ringens* in habit. See my New flora." Rafinesque's name apparently was based on the Linnaean *V. caroliniana* and was validly published with attribution of authorship to Rafinesque, analogous to the situation for *Verbena carolinana* of Michaux.

ACKNOWLEDGEMENTS

I am grateful to Kanchi Gandhi for his comments, to Dan Ward for comments on the Thomas Walter type (the lack of it) for *Phryma caroliniensis*, and to Carol Ann McCormick for confirming the presence of the *V. carnea* neotype at NCU.

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Nesom, G.L. 2010. Typification of *Verbena spuria* L. (Verbenaceae). Phytoneuron 2010-16: 1-3. Mailed 13 May 2010.

TYPIFICATION OF *VERBENA SPURIA* L. (VERBENACEAE)

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ABSTRACT

A neotype is designated for *Verbena spuria* L.—the plant mounted as *Clayton 431* in BM, apparently mislabelled, since the label information clearly refers to *V. urticifolia* L. It is possible or even probable that the plant was among those studied by Linnaeus in his formulation of the description of *V. spuria*, but since it cannot be unequivocally demonstrated to be original material, neotypification is appropriate.

KEY WORDS: *Verbena spuria*, Linnaeus, neotype

According to Jarvis (2007), a type for *Verbena spuria* has not been designated and original material has not been traced. It is argued here that a plant representing *V. spuria* indeed is in the Clayton herbarium and that it perhaps was studied by Linnaeus in the formulation of his concept of *V. spuria*. That plant, however, is mislabelled as *V. urticifolia*. Because it cannot be unequivocally demonstrated to be original material, the Clayton plant is designated as neotype.

Verbena spuria L., Sp. Pl. 1: 20. 1753. *Verbena officinalis* L. var. *spuria* (L.) Hook., Companion Bot. Mag. 1: 176. 1836. **NEOTYPE** (designated here): **[USA]**. Virginia. *Clayton 431*, the plant but not the accompanying label, which misidentifies it as *V. urticifolia* (BM-Clayton digital image!).

The protologue for *Verbena spuria* is this: "12. VERBENA tetrandra, spicis filiformibus, foliis multifido-laciniatis, caulibus numerosis. *Hort. ups.* 8. Veronica humilior, foliis incisis. *Clayt. virg.* 8. Habitat in Canada, Virginia." This essentially repeated the text of *Verbena* species No. 3 of Hortus Upsalensis—also repeating the references to the relevant page number from that publication ("*Hort. ups.* 8") as well as from a species in Gronovius's Flora Virginica ("*Clayt. virg.* 8").

Verbena No. 3 in Hortus Upsalensis is described in this way: "3. VERBENA tedrandra [sic], spicis filiformibus, foliis multido-lacinitis, caulibus numerosis. Verbena humilior foliis incisis. *Clayt. virg.* 8." The first phrase is repeated from a description in Hortus Cliffortianus that clearly refers to *V. officinalis*. The second phrase is repeated from the brief description on p. 8 of Flora Virginica.

Only a single collection of *Verbena* sensu stricto is in the BM-Clayton herbarium—the one identified as *V. urticifolia* (*Clayton 431* from Virginia, annotated by J.L. Reveal in 1990 as a syntype of *V. urticifolia*), the one apparently presumed to be associated by Gronovius in Flora Virginica (p. 7) with the concept of *V. urticifolia*. This specimen, however, is not *V. urticifolia* but instead *V. officinalis*.

The *Clayton 431* label obviously was intended originally for a collection of *Verbena urticifolia*, because the label information matches the concept of that species: "Verbena alta fol. urticae, fl. dilute caeruleis spicatum in summis caulibus congestibus, Clayt. n. 431," this repeated in the Flora Virginica text (p. 7) for *V. urticifolia*. But the leaves on the Clayton specimen are linear-

oblong, the margins not at all serrate but instead with a few narrow proximal lobes, the spikes are few and uncrowded, the fruits are distantly remote but distinctly larger than in *V. urticifolia*, and the corollas are larger than in *V. urticifolia*. There would have been no other species other than *V. officinalis* in Clayton's area that could have matched this collection. *Verbena officinalis* probably was planted by the early colonists for its medicinal properties and perhaps already was naturalizing when Clayton collected it.

Because the plant mounted on the *Clayton 431* sheet does not match the concept of *V. urticifolia*, and because even the early descriptions of *V. spuria* (or *V. officinalis*) and *V. urticifolia* are distinct, it is probable that confusion in labeling occurred. Reveal (1985) noted other examples of misapplication of names resulting from specimens mislabelled by Gronovius and Linnaeus. The plant with the *431* label, however, could match the briefer description on p. 8 of Flora Virginica ("VERBENA humilior foliis incisis. *Clayt.*"), especially since it presumably would have been an unnumbered collection ("*Clayt.*") before the *431* label was mistakenly associated with it. Published descriptions of *V. spuria* only referred to, directly or indirectly, the species on p. 8 of Flora Virginica, without reference to a numbered collection by Clayton. Linnaeus cited "Gron. virg. 7" (referring directly to the description on p. 7, thus indirectly to *Clayton 431*) in association with *V. urticifolia* in both Hortus Upsalensis and Species Plantarum, but it is unlikely that he would have identified the plant now associated with *Clayton 431* as *V. urticifolia*, so dissimilar is it.

Verbena urticifolia has been lectotypified by a LINN specimen by Méndez Santos and Cafferty (2001, p. 1140). They noted that, as part of the original material, *Clayton 431* was "seen by Linnaeus," but in the interpretation here, Linnaeus may not have seen a Clayton plant of bonafide *V. urticifolia*, since he only referred to the description by Gronovius. The path and ultimate fate of the Clayton collection properly associated with the *431* label is unknown.

***Verbena officinalis* and *V. spuria* in North America**

Early North American floristic accounts by Michaux (1803) and Pursh (1814) included *Verbena spuria* but not *V. officinalis*. Subsequent treatments by Torrey (e.g., 1826) and Gray (e.g., 1848) also included *V. spuria* (without *V. officinalis*), but the revised edition of Gray's Manual of Botany (1859) apparently was the first to treat it as a synonym of *V. officinalis*. Gray studied in London in 1838-1839 and 1855 (Dupree 1959) and perhaps on the second of these trips became convinced of the equivalence of the two names.

A plausible explanation of the choice of the epithet "spuria" supports the synonymy of *Verbena spuria* and *V. officinalis*. Linnaeus would have recognized the resemblance of the plant in the American collection to the European *V. officinalis*, and although he was familiar with *V. officinalis* and surely aware of variability in its native range, he may have been reluctant to identify the American plant as the same species. A comparison of authentic and inauthentic is implicit in the definition of "spurious."

ACKNOWLEDGEMENTS

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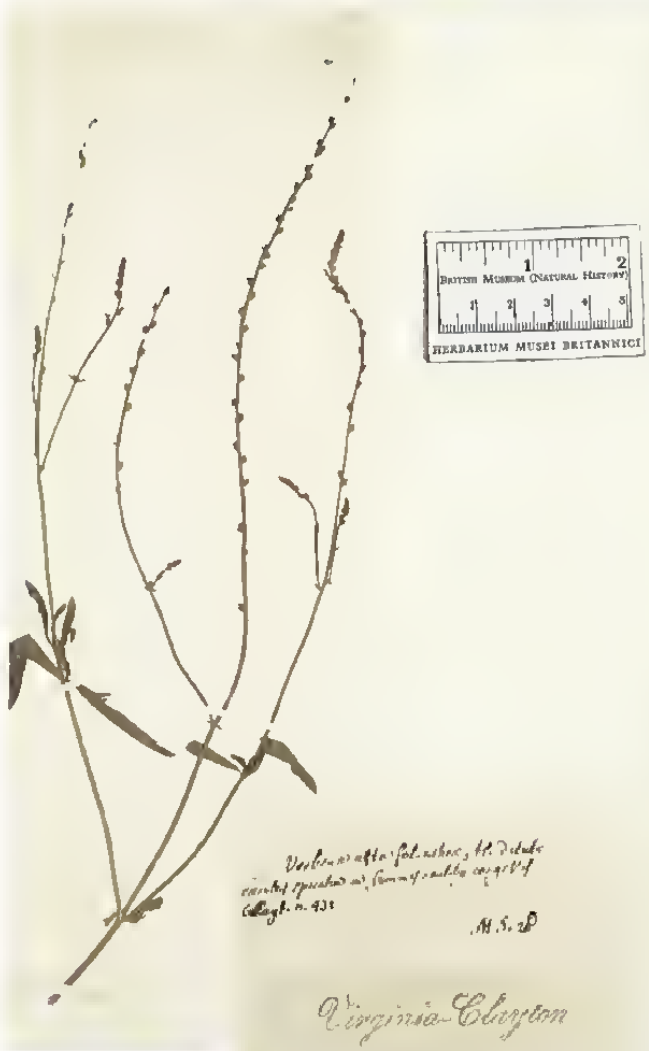

Figure 1 (left). Neotype of *Verbena spuria* L., *Clayton 431* at BM (see text).

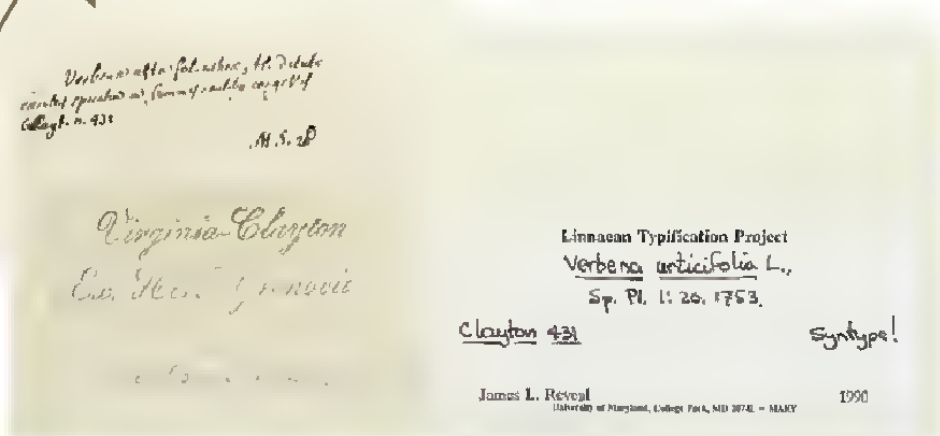

Figure 2 (below). Label of *Clayton 431*, enlarged and superposed.

Nesom, G.L. 2010. Geography of unifoliolate taxa of *Fraxinus* (Oleaceae). Phytoneuron 2010-17: 1–6. Mailed 13 May 2010.

GEOGRAPHY OF UNIFOLIOLATE TAXA OF *FRAXINUS* (OLEACEAE)

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ABSTRACT

Consistently unifoliolate forms exist in two North American species of *Fraxinus*: *F. anomala* (unifoliolate *F. anomala* var. *anomala*) and *F. greggii* (unifoliolate *F. greggii* var. *nummularia*). Taxonomic recognition of the unifoliolate forms has been inconsistent, but in each species they occupy a distinct geographic range, allopatric with the multifoliolate forms, are treated here at varietal rank. For each species, the two varietal taxa are mapped. Lectotypes are designated for the typical expressions of *F. anomala* and *F. greggii*.

KEY WORDS: *Fraxinus anomala*, *F. greggii*, Oleaceae, unifoliolate

Unifoliolate forms exist in two North American species of *Fraxinus*: *F. anomala* Torr. ex S. Wats. (the typical expression is unifoliolate) and *F. greggii* A. Gray (var. *nummularis* is unifoliolate). These two species are not closely related within the genus (*F. anomala* in sect. *Dipetalae*, *F. greggii* in sect. *Pauciflorae*; Wallander 2008), and unifoliolate forms also occur sporadically in other species (Wagner et al. 1988). Taxonomic treatment of the unifoliolate vs. multifoliolate forms in *F. anomala* and *F. greggii* has been inconsistent and the most recent classification of the genus (Wallander 2008) treated both species in the broad sense, without recognizing infraspecific variants. The present study documents the geographic distinction of the unifoliolate forms, which supports their recognition as distinct evolutionary and taxonomic entities in both species.

1. Fraxinus anomala Torr. ex S. Wats. in King, Rep. Geol. Explor. 40th Parallel [Bot. Fortieth Parallel] 5: 283. 1871. **LECTOTYPE** (designated here): **USA**. Utah. [Emery/ Grand/ Wayne/ San Juan Co.]: Labyrinth Cañon, Grand River, tree 15 ft high, 28 Aug 1859, *Dr. Newberry s.n.* (NY, NY-digital image!, GH-fragment! [packet of fruits] "ex herb. Torrey (NY)"; isolectotype: US, US-digital image!). Protologue: "A small tree, 15 high, first discovered by Newberry on Macomb's Expedition in 1859 in Labyrinth Cañon on the Colorado River, Utah, and again recently collected by Palmer near St. George on the Rio Virgen in the southwestern portion of the State." SYNTYPE: Utah. Washington Co.: near St. George on the Rio Virgen, 1870, *Dr. E. Palmer s.n.* (GH! mounted on sheet with 3 other fragmentary collections; possible duplicate, US digital image!, "S. Utah, 1877, *Dr. E. Palmer*," mounted with lectotype of *F. anomala*).

1a. Fraxinus anomala var. **anomala**

1b. Fraxinus anomala var. **lowellii** (Sarg.) Little, J. Wash. Acad. Sci. 42: 370. 1952. **Fraxinus lowellii** Sarg. in Rehder, Proc. Amer. Acad. Arts 53: 211. 1917. **TYPE**: **USA**. Arizona. Coconino Co.: Oak Creek Canyon, [S of] Flagstaff, shrubby tree, 25 feet tall, 13 Jul 1914, *A. Rehder 53* (holotype: GH!; isotypes: GH-2 sheets!, MO!, NY-digital image!, US-digital image!).

Fraxinus anomala var. *triphylla* M.E. Jones, Proc. Calif. Acad. Sci., ser. 2, 5: 707. 1895. **TYPE**: **USA**. Arizona. [Mohave Co.:] Pagumpa, among rocks, at the lower edge of the juniper belt, in the Grand Wash, 4000 ft, 20 Apr 1894, *M.E. Jones 5082* (holotype: US, US-digital image!).

Fraxinus anomala in its typical expression in unifoliolate (hence the epithet); var. *lowellii* is multifoliolate. Wilken (1993) treated the species in California without reference to infraspecific variation. Both Holmgren (1984) and Welsh et al. (2003) treated *F. anomala* var. *triphylla* as a synonym of *F. anomala* sensu lato (as inferred from their geographical summaries) but did not mention *F. lowellii* at the rank of species or variety. The PLANTS Database (USDA-NRCS 2009) recognizes var. *lowellii* but restricts it to Arizona. As seen in Fig. 1, there are two geographic entities and the morphological distinction between them is clear. Variants within each entity, however, suggest that genetic divergence between the two is minimal. It is not apparent that gene flow underlies the variation, especially in var. *lowellii*, where trifoliolate variants (see comments below) occur over its whole range, not just in the area where it closely approaches the typical element of the species. The species is regarded here as constituting two essentially parapatric varieties, perhaps slightly allopatric in southern Nevada and possibly California.

Localities for *Fraxinus anomala* in the Utah Atlas (Shultz et al. 2006) show a fuller distribution but the overall pattern is nearly identical with that mapped here. Similarly, localities from Seinet (2009) add some density to the distribution in Arizona but do not alter the overall pattern. Miller (1955) included "Wyoming" in the geographical summary for the species, but it has not been treated for the state in floristic summaries (e.g., Dorn 2001).

In the original description of *Fraxinus lowellii*, Rehder (1917) cited collections from Coconino, Yavapai, and Mohave counties and distinguished it in a key from *F. anomala* by its leaves "pinnate, 3–7-foliolate" (vs. leaves "simple, only occasionally 3-foliolate"). He noted (p. 212) that "This very distinct species [*F. anomala*] occurs within our area only in northern Arizona and in the extreme northwestern corner of New Mexico and extends into Utah and Nevada. It shows little variation; the variety *triphylla* Jones can hardly be considered a distinct form or variety, as trifoliolate leaves are likely to appear on any vigorous shoots of normal simple-leaved plants." In relegating *F. lowellii* to synonymy, Miller (1955, p. 50) noted that "the type of leaf and the variability in shape are results of the genetic variability of *F. anomala* expressed throughout its range, and need not be named." Shreve & Wiggins (1964, p. 1086) relied on a more typological justification: "Both simple and trifoliolate leaves occur on an occasional shrub, hence the varietal recognition of the trifoliolate variant is unwarranted."

In the range of var. *anomala*, leaves are consistently 1-foliolate, but occasionally on fast-growing shoots, groups of 3-foliolate leaves are produced. At the tips of spur shoots, the leaves apparently usually are 1-foliolate, even on the branches where 3-foliolate leaves are produced on the distal shoots—e.g.: California, San Bernadino Co., Providence Mts., 31 Jul 1940, *Wolf 9732* (TEX); Nevada, Clark Co., canyon E of Mountain Springs, 22 Apr 1939, *Clokey 8453* (GH); Utah, [Emery Co.], San Rafael Swell, 11 May 1914, *Jones s.n.* (GH). In label notes for *Cronquist 10024* (TEX) from Kane Co., Utah, the collector noted "leaves typically simple but often some of them 3-foliolate or lobed, especially on vigorous shoots. A few plants with the leaves largely trifoliolate, even on short spurs." Welsh et al. (2003) noted that in Utah "Uncommonly some of the leaves are modestly compound with a pair of leaflets below the terminal one."

In the range of var. *lowellii*, leaves are consistently 3–5-foliolate, but 1-foliolate ones sometimes are produced on mostly multifoliolate plants. In the Mazatzal Mountains of Maricopa Co., Arizona, an area where many collections of typical var. *lowellii* have been made (especially around Payson and Pine), Susan McKelvey made numerous collections on the "road to Amethyst Mine" (11 May 1929). Of three sheets of *967* (perhaps the same tree), two have branches with 3–5 leaflets, while one has two branches with 3 leaflets and two branches with single leaflets arising from young shoots. Other collections by McKelvey (*890*, *961*, *964*) from the same area, on the same day, have

3(–5) leaflets. In the Mogollon Mountains of southwestern New Mexico, a collection by E.L. Greene (27 Apr 1881, *Greene s.n.*, GH) has 3-foliolate leaves on shoots with 1-foliolate leaves at the spur tips.

2. Fraxinus greggii A. Gray, Proc. Amer. Acad. Arts 12: 63. 1876. **LECTOTYPE** (designated here): **Mexico**. [Coahuila]. Low grounds near Rinconada, 5 Jan 1847, *J. Gregg s.n.* (GH 73811!). After the brief protologue description, Gray cited "*F. Schiedeana* var. *parvifolia*, "Torr. Bot. Mex. Bound. 166. — S. W. Texas, and adjacent parts of Mexico, Gregg, Schott, Bigelow, Parry." Two syntypes are mounted on the same sheet as the lectotype: USA. Arizona. Near Painted Caves, 18 Sep 1852, *J.M. Bigelow s.n.* (GH 73813); Mexico. [Coahuila]. Santa Rosa Mountains, no date, *J.M. Bigelow s.n.* (GH 73812). The type locality (La Rinconada) is about 30 kilometers directly south of the center of Monclova.

Fraxinus schiedeana Schltdl. & Cham. var. *parvifolia* Torr., Rep. U.S. Mex. Bound. 2(1): 166. 1859. **LECTOTYPE** (designated here): **Mexico**. [Coahuila]. Low grounds near Rinconada, 5 Jan 1847, *J. Gregg s.n.* (GH 73811!). Protologue: "Rocky places in limestone districts on the Rio Grande, from the San Pedro to the Pecos; *Schott.* Mountains of Santa Rosa, Coahuila; *Bigelow, Parry.*" As lectotypified here, this taxon is homotypic with *F. greggii*.

2a. Fraxinus greggii var. **greggii**

2b. Fraxinus greggii var. **nummularis** (M.E. Jones) Little, J. Wash. Acad. Sci. 42: 375. 1952. *Fraxinus nummularis* M.E. Jones, Contr. Western Bot. 12: 59. 1908. *Fraxinus greggii* forma *nummularis* (M.E. Jones) C.H. Mueller, Amer. Midl. Naturalist 3: 187. 1914. *Fraxinus greggii* subsp. *nummularis* (M.E. Jones) A.E. Murray, Kalmia 15: 11. 1984. **TYPE**: **Mexico**. Coahuila. Sierra Mojada, 19 Apr 1892, *M.E. Jones s.n.* (holotype: US, US-digital image!).

Miller (1955, p. 54) observed that the 'nummularis' form is "the designation of a varietal extreme within a rather wide genetic variability found in the shape and texture of the leaves of *Fraxinus greggii*." In the Texas manual, Correll and Johnston (1970) did not include synonyms for *F. greggii* or note even the possible occurrence of infraspecific variation. Powell (1997) included var. *nummularis* as a synonym. Almost all of the unifoliolate populations, however, are in northwestern Mexico where critical comparisons in a broad floristic summary have not yet been made. In a pattern analogous to that in *F. anomala*, the unifoliolate plants of *F. greggii* (var. *nummularis*) are geographically distinct from the typical multifoliolate ones (Fig. 2), and the species is treated here as comprising two parapatric (or slightly allopatric) varieties.

Of two collections by Johnston & Mueller from Picachos Colorados, *129* is 3–5-foliolate, while *130* (GH) is mostly 1-foliolate; *130* (LL) has a mixture of 1- and 3-foliolate leaves. From the Sierra del Pino, *Johnston & Muller 387* (GH, LL) and *387A* (GH) have a mixture of 1-foliolate and 3-foliolate leaves; *387B* has all 1-foliolate leaves. From the Sierra Almagre, *Johnston & Mueller 1217* and *1218* have very small, very broadly obovate leaves.

Similar variation occurs in Brewster Co., Texas, where the two expressions occur together. Because the var. *nummularis* has not previously been recognized in the USA, vouchers are cited here: Texas. Brewster Co., Chisos Mts.: Big Bend Natl. Park, Window Trail, 17 Jun 1963, *Correll & Wasshausen 27893* (LL); Aug 1936, *Hinckley s.n.* (TEX-2 sheets); S-facing slope on trail from Basin to Laguna Meadows, 5800 ft, 12 Mar 1978, *Moir s.n.* (TEX); 9 Jul 1931, *Mueller 8113* (MO); rocky slopes and banks of canyons, 23 May 1928, *Palmer 34116* (MO); Chisos Basin, common, N and E exposures of limestone ridges N of Ward Mt., 19 Aug 1969, *Whitson 433* (SMU); Nail place, 11 Aug 1915, *Young s.n.* (TEX). Examples of typical, 3-5-foliolate plants from the Chisos Mountains are these: trail to Laguna, 21 Jul 1957, *Correll & Johnston 18288* (LL); Window Trail, 7 Jul 1944, *Cory 44744* (TEX).

Attributions of *Fraxinus greggii* to Arizona, New Mexico, and Sonora (e.g., USDA-NRCS 2009) have been of collections now identified as *F. gooddingii* and *F. cuspidata*. "In Arizona Flora, this specimen [*Goodding s.n.*, from Santa Cruz Co., the type of *F. gooddingii* Little] was cited under *F. greggii*, a species of southwestern Texas and northeastern Mexico" (Kearney & Peebles 1969).

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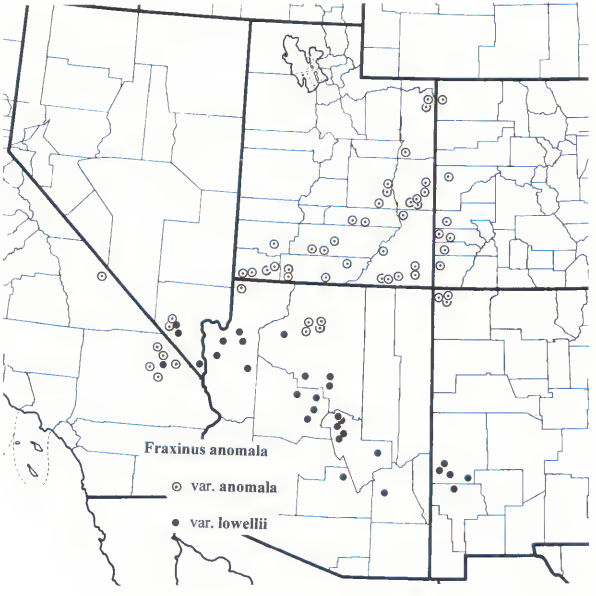

Figure 1. Distribution of *Fraxinus anomala* var. *anomala* and var. *lowellii*.

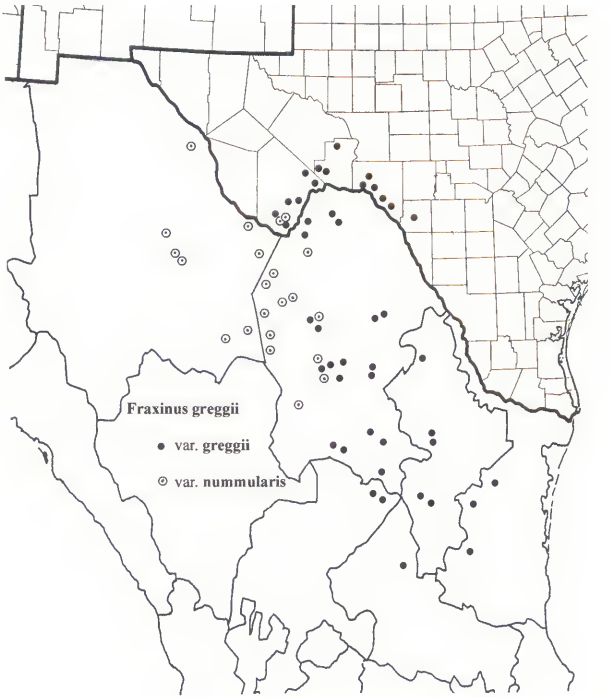

Figure 2. Distribution of *Fraxinus greggii* var. *greggii* and var. *nummularis*.

Nesom, G.L. 2010. Sectional name for the group including *Erigeron radicatus* (Asteraceae: Astereae). Phytoneuron 2010-18: 1-2. Mailed 13 May 2010.

SECTIONAL NAME FOR THE GROUP INCLUDING *ERIGERON RADICATUS* (ASTERACEAE: ASTEREAE)

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ABSTRACT

Erigeron sect. *Radicati* (Rydb.) Nesom (of 2008) was without a clear taxonomic position as published—it is lectotypified here by *E. nematophyllus* and becomes a synonym of *Erigeron* sect. *Wyomingia* (of 1947). **Erigeron** sect. **Radicatiformes** Nesom, sect. nov. (type: *E. radicatus*) is described here to include the five species placed in error within sect. *Radicati* in 2008.

In a classification of the Conyzinae (Nesom 2008), the combination *Erigeron* sect. *Radicati* (Rydb.) Nesom was formalized, based on *Erigeron* [unranked] *Radicati* Rydberg (1906), as the name for a group including *E. radicatus* Hook. as well as *E. lackschewitzii*, *E. ochroleucus*, *E. parryi*, and *E. rydbergii*. *Erigeron radicatus*, however, does not occur in Colorado, and it was not among the five species of Rydberg's *Radicati* group in his Flora of Colorado (1906), although Rydberg later (1917) included *E. radicatus* in that group and probably had earlier intended to imply its membership there.

In any case, Rydberg's "Radicati group" of 1906 cannot stand as the basionym of a name for the 2008 group, because none of the species in the 1906 group were in the 2008 group—all were in different sections.

Rydberg's Radicati:
Erigeron engelmannii, *E. vetensis* (syns = *E. glandulosus*, *E. viscidus*) — in sect. **Stenactis**, 2008
Erigeron leiomerus — in sect. **Scopulincola**, 2008
Erigeron nematophyllus — in sect. **Wyomingia**, 2008
Erigeron peasei (= *E. flagellaris*) — in sect. **Olygotrichium**, 2008
Erigeron ursinus — sect. **Rhizonexus**, 2008

Thus, because of the superfluous and rejected type citation, *Erigeron* sect. *Radicati* is valid and legitimate but, without a lectotype species, it lacks a clear taxonomic position.

The situation is clarified and rectified here by described a new section, correctly typified, for the group of 2008 and by providing a lectotype for *Erigeron* sect. *Radicati*

Erigeron sect. **Radicatiformes** Nesom, sect. nov. **TYPE**: *Erigeron radicatus* Hook.

Caudice multicipitali, radice palari, caulibus simplicibus capitulis 1(–3), foliis oblanceolatis vel spatulatis abaxialiter glabris vel glabratis, et achaniis 1.8–2.8 mm in longitudine distinctus.

Species included: *E. lackschewitzii* Nesom & Weber, *E. ochroleucus* Nutt., *E. parryi* Canby & Rose, *E. radicatus* Hook., and *E. rydbergii* Cronq.

Erigeron sect. **Radicati** (Rydb.) Nesom, Lundellia 11: 26. 2008. *Erigeron* [unranked] *Radicati* Rydb., Fl. Colorado 359. 1906, in clave. Lectotype (designated here): *Erigeron nematophyllus* Rydb. With this lectotypification *Erigeron* sect. *Radicati* becomes a synonym of *Erigeron* sect. *Wyomingia* (A. Nels.) Cronq., as delimited in Nesom (2008).

ACKNOWLEDGEMENTS

I'm grateful to Kanchi Gandhi for pointing out the problem in typification with my original elevation in rank of Rydberg's Radicati group.

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CARISSA MACROCARPA (APOCYNACEAE): NEW TO THE TEXAS FLORA

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ABSTRACT

Carissa macrocarpa (Eckl.) A. DC. is documented as occurring outside of cultivation in Texas. Several colonies were found growing on shell middens in Nueces County. It is suspected that seeds were dispersed from landscape plantings in the Corpus Christi area. *Carissa macrocarpa* has moderate invasive potential along the Texas coast.

KEY WORDS: Apocynaceae, *Carissa macrocarpa*, Texas, naturalized.

Carissa macrocarpa (Eckl.) A. DC. (Apocynaceae), commonly known as Natal plum, was recently documented as naturalizing in Nueces County, Texas. The species has not been previously reported outside of cultivation in Texas (Correll & Johnson 1970; Hatch 1990; Jones et al. 1997; Turner et al. 2003).

Carissa macrocarpa is native to the coastal region of Natal, South Africa. It was introduced into the United States in 1886 by the horticulturist Theodore L. Meade. In 1903, David Fairchild of the Office of Foreign Seed and Plant Introduction of the United States Department of Agriculture imported a large quantity of seeds from the Botanical Garden at Durban, South Africa. Several thousand seedlings were raised at the then Plant Introduction Garden at Miami and distributed for testing in Florida, the Gulf states and California. Extensive effort was devoted to following up on the fate of the plants in different climatic zones. *Carissa macrocarpa* was introduced into Hawaii in 1905 and over the next few years was extensively distributed throughout the islands. It was planted in the Bahamas in 1913. It first fruited in the Philippines in 1924 and is grown to a limited extent in India and East Africa. The species is valued mainly as a protective hedge, while the fruit is edible and suitable for fruit salads, cakes, puddings ice cream, pies, and tarts. The summary information above on *Carissa macrocarpa* is taken from Morton (1987).

Carissa macrocarpa (Fig. 1) was found growing on shell middens in Nueces County. It is suspected that seeds were dispersed from landscape plantings, possibly by birds, in the Corpus Christi, Texas area. Three colonies (averaging 3 x 3 meters) were documented at this site. These colonies are reproducing vegetatively with branches rooting low to the ground. Elsewhere in the USA, *Carissa macrocarpa* is known to be naturalized only in Florida, where Wunderlin and Hansen (2010) report that it occurs in seven counties.

Voucher specimen: USA. **Texas**. Nueces Co.: Padre Balli Park (Nueces County park lands), north end of Padre Island, jct of Windward and Lee Ward Drive, 17 May 2010, *Singhurst 18265* (BAYLU).

Shell middens (or shell mounds) in the mid-Gulf coast of Texas are located on the back side of dunes and are composed of shells (clams, oysters, whelks) with inter-dispersed sand. The middens support an assemblage of calciphilic plants. The dominant flora of the shell middens includes *Opuntia stricta*, *Dalea emarginata*, *Heterotheca subaxillaris*, *Indigofera mimata*, and *Yucca treculeana*. Other common associates include *Aphanostephus skirrhobasis*, *Chamaecrista fasciculata*, *Chamaesyce* sp., *Chloris* sp., *Croton punctatus*, *Cyperus* sp., *Dichanthelium* sp., *Distichlis spicata*, *Gaillardia pulchella*, *Ibervillea lindheimeri*, *Orobanche ludoviciana*, *Rhynchosia americana*, *Oenothera drummondii*, *Paspalum* sp., *Plantago hookeriana*, *Portulaca pilosa*, and *Sporobolus pyramidatus*. See Slater and Kincaid (2004) for a discussion of the botany of shell middens in Florida.

Fig. 1. *Carissa macrocarpa* (Natal plum) in Nueces County, Texas

Carissa macrocarpa (Figs 1, 2) is a vigorous, spreading woody shrub with abundant, gummy-white sap. It may reach a height of 4.5–5.5 m and an equal breadth. The branches are armed with stout, double pronged thorns of up to 5 cm long. Leaves are evergreen, opposite, broad-ovate, 2.5–5 cm long, dark green, glossy, and leathery. Flowers are sweetly fragrant, white, 5-lobed with tubes to 5 cm and are borne singly or few together at the tips of branches. The fruits are ovoid to spheroid, to 6.25 cm long and 4 cm wide. Upon ripening, the tender smooth skin turns a bright magenta-red. The fruit contains 6–16 small, flat, brown seeds.

Fig. 2. *Carissa macrocarpa* (Natal plum) in flower.

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Nesom, G.L. and T.R. Van Devender. 2010. *Verbena moctezumae* (Verbenaceae), a new species from Sonora, Mexico. Phytoneuron 2010-20: 1-5. Mailed June 21.

VERBENA MOCTEZUMAE (VERBENACEAE), A NEW SPECIES FROM SONORA, MEXICO

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ABSTRACT

Verbena moctezumae Nesom & Van Devender, sp. nov., is described from east-central Sonora, Mexico, where it apparently is narrowly endemic to an area of basalt. The new species is distinct in its annual duration and reduced habit, essentially glabrous stems, persistent and oblanceolate, serrate-margined basal and lower cauline leaves 15–30 mm long, leaf surfaces, rachises, and calyces are densely and minutely stipitate- to subsessile-glandular, and short, solitary spikes with medium sized flowers. The strongly developed stem angles, thin leaves with non-revolute margins, and fruits with commissural faces reaching the nutlet tips suggest that it is most closely related to *V. menthifolia* and others of ser. *Verbena*.

KEY WORDS: *Verbena*, Verbenaceae, new species, Mexico, Sonora

As part of a project to document and summarize the flora of the state of Sonora, Mexico, many areas in the state have been floristically inventoried by Van Devender, Ana L. Reina-Guerrero, Richard S. Felger, J. Jesús Sánchez-Escalante, and others in recent years. The *malpais* basalt lava flows near Moctezuma is prime area of interest. The current status of the flora was recently summarized in Van Devender et al. (2009). All of the collections as well as observations are being entered into the Madrean Archipelago Biodiversity database (Madrean.org) at Sky Island Alliance, Tucson, Arizona. These studies have brought to light a previously undescribed species of *Verbena*.

Verbena moctezumae Nesom & T. Van Devender, sp. nov. (Fig. 1).

A *Verbenae menthifoliae* ac speciebus cognatae similis sed distinctus duratione annuo habitu redacto, caulibus quasi glabris, foliis rachidibus calycibusque dense minute stipitati-glandularibus, foliis basalibus proximalibus persistentibus parvis marginibus serratis nonrevolutis, et spicis brevibus solitariis floribus mediocribus.

TYPE: Mexico. Sonora. Mpio. de Moctezuma: 23.3 km SSE of jct with Moctezuma-Huásabas Hwy on road to Tepache (SON 117), 21.4 km (by air) SSE of Moctezuma, sparse open foothills thornscrub on basalt cobble plain; 29º 38' 08" N, 109º 33' 25" W; 701 m elevation; rare, widely scattered annual in dark brown clay soil among black rocks, 4 May 2010, *A.L. Reina-G. 2010-358* with T.R. Van Devender (holotype: ARIZ; isotypes: MEXU, US).

Plants herbaceous annuals from a slender, unbranched taproot. **Stems** 1(–4) from the base, erect to ascending-erect, 12–21 cm, strongly 4-angled, essentially glabrous or sparsely hirsute-strigose to strigillose with upturned hairs along the angles, hirsutulous at the very base, eglandular. **Leaves** mostly basal and proximal cauline, oblanceolate to narrowly oblanceolate, blades 15–30 mm x 3–5

mm, veins impressed adaxially, margins coarsely serrate with 3–5 pairs of teeth, not revolute or very narrowly so, hirsute and densely stipitate-glandular on both surfaces, basally attenuate, midcauline and above linear and entire. **Fruiting spikes** solitary, 1.5–5 cm, densely arranged and overlapping, the proximal looser; floral bracts narrowly lanceolate to narrowly ovate-acuminate, 3.5–3.8 mm, equalling or slightly shorter than the calyces; rachis densely stipitate-glandular. **Calyces** 3–4 mm, densely and minutely stipitate- to subsessile-glandular, hirsute only along the keel and lobes, lobes narrowly triangular, erect, not connivent. **Corollas** blue with prominently white throat, tubes 4–4.5 mm, 1–1.5 mm longer than the calyx, limbs 4–5 mm in diam. **Nutlets** ca. 2 mm, commissural faces extending completely to the nutlet tips, surface morphology not seen.

Additional collection. **Mexico**. Sonora. Mpio. de Moctezuma: 20.5 km SSE of jct with Moctezuma-Huásabas Hwy on road to Tepache (SON 117), basalt cobble plain with sparse open foothills thornscrub; 29° 38' 36" N, 109° 34' 32" W; 689 m elevation; rare annual, 26 Apr 2004, *Van Devender 2004-400* (TEX).

Verbena moctezumae is a distinctive species. The plants are small annuals and arise from a thin, unbranched taproot and would not be mistaken for any other species of western Mexico. The stems are essentially glabrous, but leaf surfaces, rachises, and calyces are densely and minutely stipitate- to subsessile-glandular; leaves are primarily basal and lower cauline and are oblanceolate and serrate-margined, and the short solitary spikes bear medium sized flowers with a prominently white throat. The strongly developed stem angles, thin leaves with non-revolute margins, and fruits with commissural faces reaching the nutlet tips suggest that *V. moctezumae* is most closely related to *V. menthifolia* Benth. and others of sect. *Verbena* ser. *Verbena* (Nesom 2010a).

Besides *Verbena menthifolia*, one other species of ser. *Verbena* is native to Mexico: *V. madrensis* Nesom (Nesom 2010b). Plants of *V. madrensis* are perennial and much larger than in *V. moctezumae* (25–60[–120] cm vs. 12–21 cm), but the two are similar in their single-stemmed habit, glabrate stems with strongly nerved angles, leaves with coarsely serrate margins, densely stipitate-glandular rachises and calyces, and nutlets with commissural faces reaching the tip. The *V. moctezumae* population system lies within the range of *V. menthifolia* but is far outside the range of *V. madrensis*. Compared to *V. menthifolia*, *V. moctezumae* is immediately distinguished by its shorter duration, small size, densely stipitate-glandular leaves, rachises, and calyces, and larger corollas.

1. Plants annual, stems 12–21 cm tall; spikes 1.5–5 cm; leaf blades 15–30 mm x 3–5 mm, coarsely serrate; leaf surfaces, rachises, and calyces densely stipitate-glandular; corolla tubes 4–4.5 mm, limbs 4–5 mm in diam.; nutlets ca. 2 mm long ..... **Verbena moctezumae**
1. Plants perennial, stems (30–)40–70 cm tall; spikes 10–20(–30) cm; leaf blades 25–45(–80) cm x 15–25(–40) mm, deeply toothed to pinnately lobed; leaf surfaces and calyces eglandular, rachises eglandular to sparsely glandular; corolla tubes 2.5–3 mm, limbs 1.5–3(–5) mm in diam.; nutlets 1.4–1.8(–2) mm long ..... **Verbena menthifolia**

The epithet of the new species reflects its geography—it is within Municipio de Moctezuma, whose largest settlement and municipal seat are the town of the same name. Moctezuma (ca. 1466–1520) was leader of the Aztec Empire, the last before the arrival of the Spanish in Mexico in 1517.

The new species is only known from the extensive (ca. 275 km^2) basalt flows south of the Sierra de la Madera and west of Moctezuma in east-central Sonora. The habitat is unique with regularly spaced black stones emerging from a dark, clay-rich soil derived from the eroding basalt. This soil becomes very sticky when wet and contracts when dry. The vegetation is foothills thornscrub, which occupies a broad area between Sonoran desertscrub to the west, tropical deciduous forest to the southeast, and oak woodland in the Sky Island mountain ranges and the Sierra Madre

Occidental to the east. On the Moctezuma lava plain, foothills thornscrub is of short stature and the trees are small and widely spaced. Other plants of interest from the same area include disjunct populations of *Viguiera purisimae*, a species of Asteraceae common in Baja California and southern California, and *Croton leucophyllus*, a Chihuahuan Desert species found from Texas southward. The holotype of *Melampodium moctezumum* was collected in the same habitat, 13.7 km NNW of Tepache on road to Moctezuma (Sonora Hwy 117) (*A.L. Reina G. 2003-943*, the type at TEX; Turner 2007).

ACKNOWLEDGEMENTS

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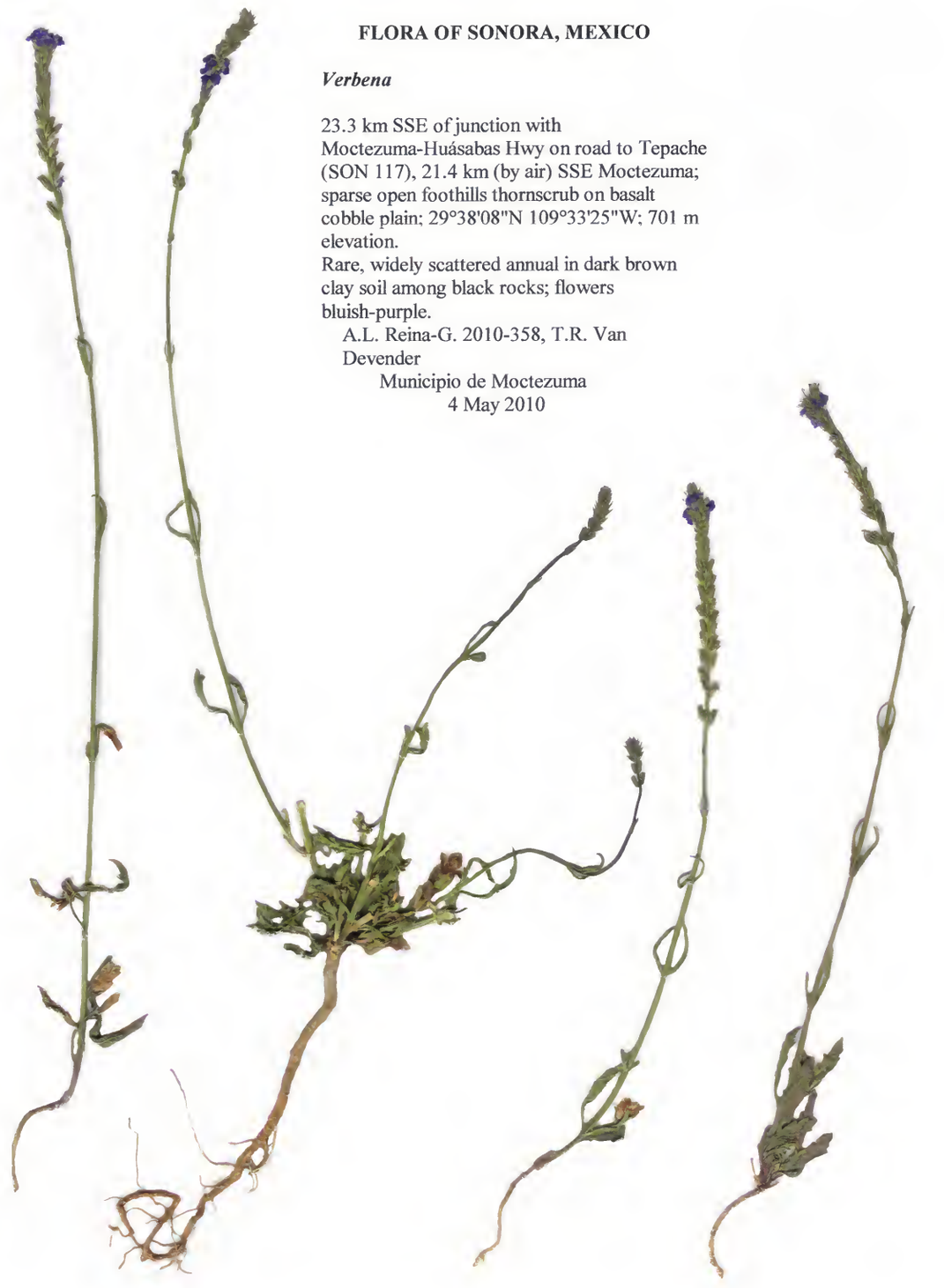

Figure 1. Holotype of *Verbena moctezumae* (to be mounted).

Fig 2. *Verbena moctezumae*, Van Devender 2004-400.

Fig. 3. *Verbena moctezumae*, Reina-G. 2010-358, at type locality, on basalt rock.

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SYSTEMATIC REEVALUATION OF THE *PHACELIA PATULIFLORA* (HYDROPHYLLACEAE) COMPLEX

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ABSTRACT

Moyer and Turner (1994) presented a treatment of *Phacelia patuliflora* in which three, allopatric, infraspecific categories were recognized: var. *patuliflora* of central Texas; var. *teucritifolia* (I.M. Johnst.) Constance of western Texas and north-central Mexico, and var. *austrotexana* J.A. Moyer of southern Texas and closely adjacent Mexico. The complex has been reassessed and it is concluded that all are worthy of specific rank since they all form relatively uniform, discrete, populations and do not intergrade. Appropriate specific names follow: *Phacelia patuliflora* (Engelm. & A. Gray) A. Gray; *Phacelia teucritfolia* I.M. Johnst.; and **Phacelia austrotexana** (J.A. Moyer) B.L. Turner, stat. nov. Distribution maps are provided along with selected statements bearing on their biological status.

KEY WORDS: *Phacelia, P. patulflora*, *P. austrotexana* sp. nov., Hydrophyllaceae, Texas, Mexico

Moyer and Turner (1994) presented a treatment of the *Phacelia patuliflora* complex, based upon a Master's thesis of the senior author (J.A. Moyer), which recognized three allopatric, infraspecific taxa: var. *patuliflora*, var. *teucritifolia*, and a newly described var. *austrotexana*. Their treatment was unduly conservative, considering the fact that all of the taxa appeared to be valid biological species deserving of specific rank, as they all form relatively uniform, discrete, populations and do not intergrade. Indeed, as Moyer's major professor, I was amiss in not encouraging her to do so. Regardless, the oversight is corrected here in the account that follows:

Phacelia patuliflora (Engelm. & A. Gray) A. Gray, Proc. Amer. Acad. Arts 10: 321. 1875. *Eutoca patulflora* Engelm. & A. Gray, Boston J. Nat. Hist. 5: 253. 1845. Fig. 2.

This name is typified by material collected in Austin Co., Texas, by Lindheimer in 1843. It is readily distinguished by its pubescence of glandular trichomes as well as other characters, as described by Moyer and Turner. The taxon has not been found to occur with other members of the complex nor have intergrades been detected.

Phacelia teucriifolia I.M. Johnst., J. Arnold Arbor. 24: 98. 1943. *Phacelia patuliflora* var. *teucritifolia* (I.M. Johnst.) Constance, Contr. Gray Herb. 168: 24. 1949. Fig. 3.

This name is typified by material collected in Musquiz, Coahuila, Mexico, by Marsh in 1936. It is readily recognized by its vestiture of short, eglandular hairs and characters of the calyx, as noted by Moyer and Turner (1994) in their trinomic key to taxa. It is relatively rare in Mexico; other than the type, it is known to me by only one other Mexican collection (Coahuila: "Rcho. Florida," ca. 100 km NW of Muzquiz, *Carranza 1539* [TEX]). The species, however, is relatively common in Texas, as indicated in Fig. 3.

Phacelia austrotexana (J.A. Moyer) B.L. Turner, comb. et stat. nov. Based upon *Phacelia patulflora* var. *austrotexana* J.A. Moyer, Sida 16: 250. 1994. Fig. 1.

This name is typified by material collected in San Patricio Co., Texas. It is abundantly represented in herbaria by collections from southern Texas and does not, to my knowledge, intergrade with other closely related taxa. Moyer and Turner (1994) observed that *Phacelia austrotexana* (as

var *austrotexana*) probably is closer to *P laxa* Small than it is to *P patuliflora* sensu stricto, which as noted by Constance (1949) appears equally close to *P strictiflora* (Engelm & Gray) A Gray

ACKNOWLEDGEMENTS

I am grateful to J.A. Moyer for her excellent Master's thesis, which called to the fore the problem addressed here, to Guy Nesom for helpful suggestions, and to Bob Harms for efficacious technical assistance with formatting of the maps. The distribution maps are based upon specimens on file at TEX-LL and, in the case of *P teucrifolia,* specimens cited in the work of Constance (1949)

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Moyer, J.A. and B.L. Turner. 1994. Systematic study of Texas populations of *Phacelia patuliflora* (Hydrophyllaceae). Sida 16: 245–252.

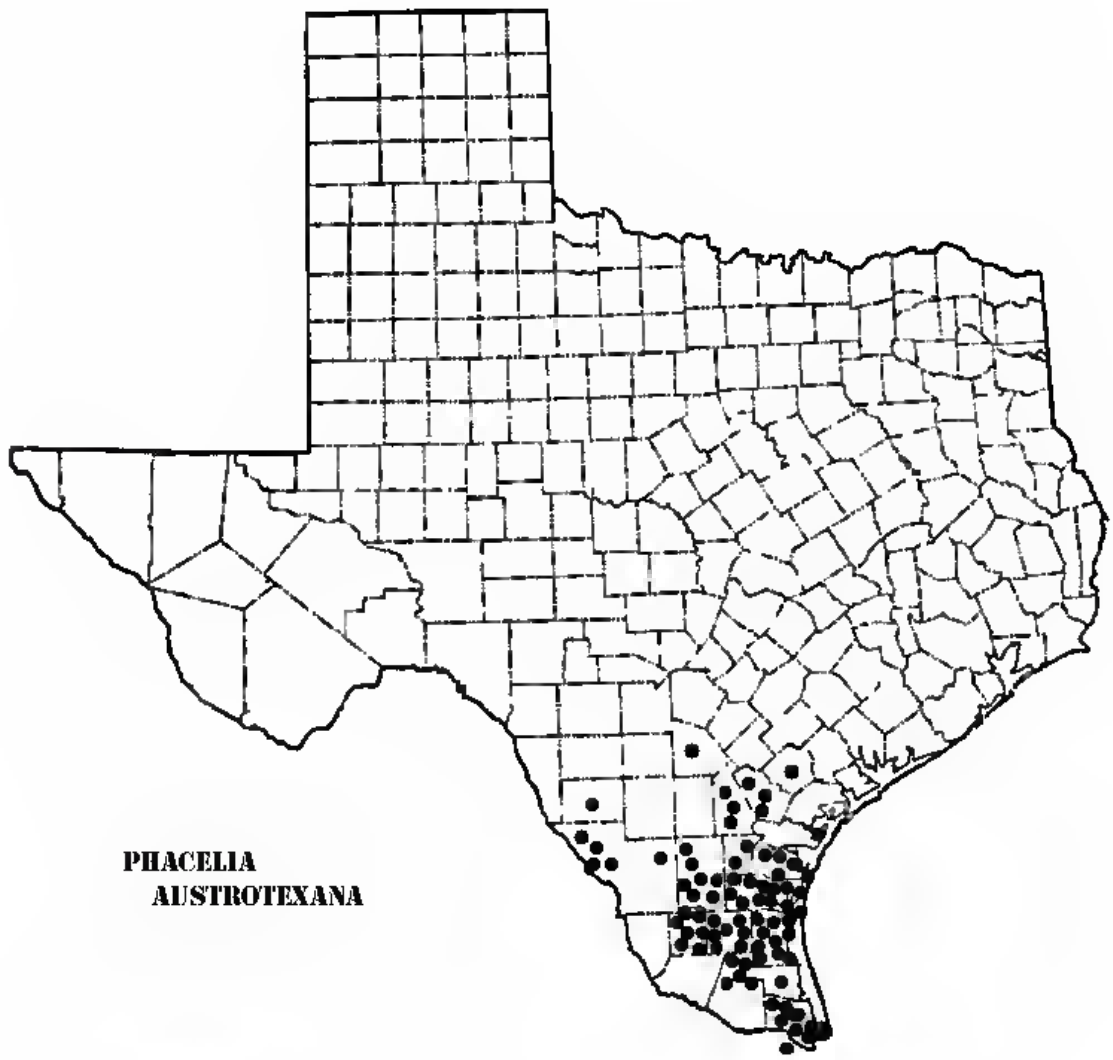

Figure 1. Distribution of *Phacelia austrotexana*

Figure 2. Distribution of *Phacelia patuliflora*.

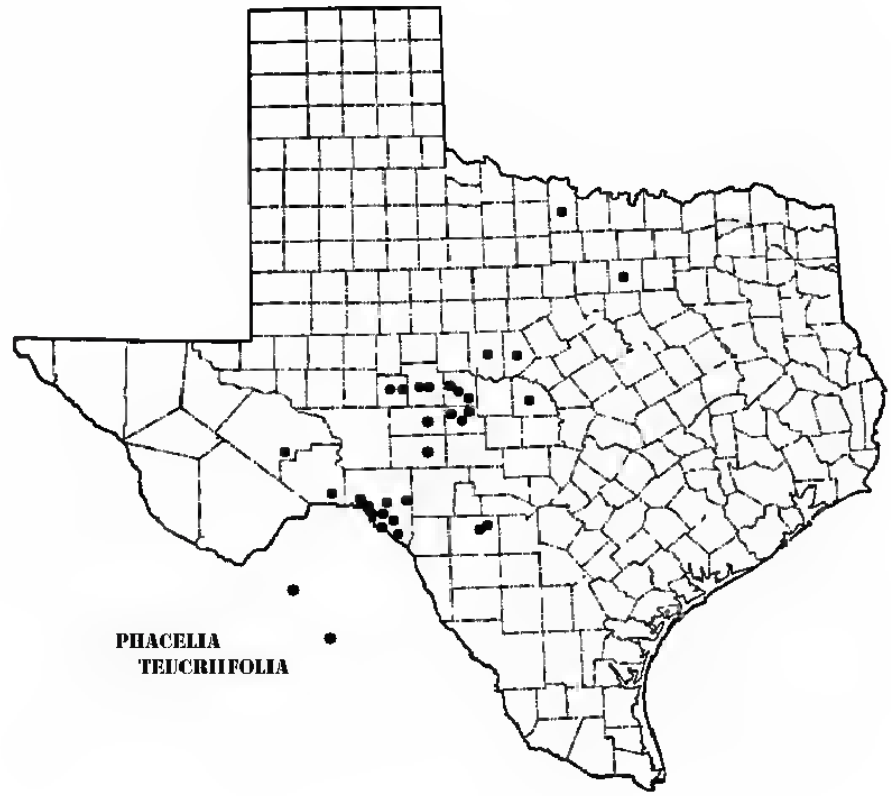

Figure 3. Distribution of *Phacelia teucrifolia*.

NEW FLOWERING PLANT RECORDS FOR THE NORTH OF MEXICO

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ABSTRACT

Adenophyllum porophyllum (Cav.) Hemsl. var. *porophyllum* is reported for Chihuahua, its presence there overlooked in a recent revision. *Adenophyllum wrightii* A. Gray var. *wrightii* is reported from two new locations, confirming a single century old record for Chihuahua. *Astragalus ervoides* Hook. & Arn. var. *maysillesii* Barneby is reported as a new record for Chihuaha. *Oxytropis lambertii* Pursh var. *bigelovii* A. Gray and *Corydalis micrantha* (Englem.) Gray subsp. *micrantha* are reported as a new records for Mexico. *Agastache pallidiflora* (Heller) Rydb. subsp. *pallidiflora* var. *gilensis* R. Sanders is reported as a first record for the species for Chihuahua and as a first record for the variety for Mexico.

KEY WORDS: New records, Mexico, Chihuahua, Sierra Madre Occidental, flowering plants

While exploring the scenic regions of the Sierra Madre Occidental of western Chihuahua, primarily for photographic purposes, we occasionally collected botanical specimens of plants that we did not know, that were of interest for ongoing research by us or others, or were in groups that are either under-collected or inherently difficult. Among those collections were a few that are of general interest for floristic work in Mexico. We present those records here.

ASTERACEAE

***Adenophyllum porophyllum* (Cav.) Hemsl. var. *porophyllum*.** Chihuahua, Mpio. de Madera, 18 air km due W of Madera on road to El Agua Amarilla, E side of Rio Sirupa 0.6 km E of bridge, 29°11'00.7"N, 108°19'27.8"W; elev. 1435 m, open grassy area with many Asteraceae, rocky, with *Quercus chihuahuensis* and *Q. oblongifolia*. Heads rayless; flowers yellow orange; plants sporadic among other annual and perennial herbs, not common; 28 Sep 2007, *R. Spellenberg* and *W. Anderson 13862* (CIIDIR, MEXU, NMC, UC).

Confirms presence in Chihuahua. John Strother kindly confirmed our identification and noted that he inadvertently omitted an earlier Chihuahua record from his citations of specimens for *Dyssodia prophylla* (Cav.) Cav. subsp. *porophylla* var. *porophylla* in his revision of *Dyssodia* (Strother 1969). He later recognized this group of *Dyssodia* in the genus *Adenophyllum* (Strother 1986).

***Adenophyllum wrightii* A. Gray var. *wrightii*.** Mpio. de Madera, 15 km S of Nicolas Bravo, 1.6 km N of junction with Chih. Hwy. 10 to San Jose de Babícora, 29°11'14.6"N, 107°52'28.9"W; elev. 2230 m, in silty igneous sandy gravel in small drain that passes under highway in semi-open area in *Juniperus deppeana, Pinus latifolia, Quercus arizonica* woods, with *Bidens odorata, B. lemmonii (?), Schkuhria, Cosmos, Muhlenbergia minutissima,* and sparse *Bouteloua hirsute* and *B. gracilis*. Plants erect; rays yellow; restricted to ca. 4×5 m area; 28 Sep 2007, *R. Spellenberg* and *W. Anderson 13847* (CIIDIR, MEXU, NMC, UC); Mpio. de Temosachi, on Chih. Hwy 10 2 km NE of junction with

Chih. Hwy 10 to Madera (ca. at La Concha) and Matachic 29°07'50.1"N, 107°54'09.6"W., 29°11'14.6"N, 107°52'28.9"W, elev. 2230 m, rocky hills with *Pmus, Juniperus, Quercus.* Plant common in gravel of roadside, in low vegetated areas along road, and standing alone, ungrazed, in heavily overgrazed pasture; plants erect; rays yellow; 28 Sep 2007, *R. Spellenberg* and *W. Anderson 13848* (BRIT, MEXU, NMC, UC).

Confirms presence for Chihuahua: These seem to be the first collections in 120 years for this taxon in Mexico. It apparently was not encountered during a rather thorough survey of the Cuenca de la Laguna Babicora (Estrada C. et al 1997), an area which includes the location of the first record cited. Strother (1969) reported it for Chihuahua from a single Pringle collection near Cd. Guerrero in 1887 (as *Dyssodia neomexicana* (Gray) Rob. var. *neomexicana*), somewhat south of our records. We found the species to be weedy at the second site and completely avoided by cattle in a very heavily grazed pasture. These records and observations, along with several locations discovered within the same general period in New Mexico, convinced conservationists in New Mexico that the species did not require protection (http://nmrareplants.unm.edu).

FABACEAE

***Astragalus ervoides* Hook. & Arn. var. *maysillesii* Barneby**. Chihuahua, Mpio.Bocoyna, along road into Valle de los Monjes, ca. 5 km SE of Creel, 27°43'43"N, 107°35'11.8" W; open gray igneous rock with patches of thin soil, with pine, elev. 2345 m. Stems decumbent-ascending, petals white, the keels tinged with dull purple, stipe, if present, 0.10-0.15 mm long, pod 2-celled, dark brown-black at maturity; 27 Aug 2004, *R. Spellenberg 13480* (CFNL, NMC).

Apparent first record for Chihuahua for species. Barneby (1964) mapped the variety from approximately 300 km to the south, from southwestern Durango, where it is common. We have noted the taxon at several sites within this region in Chihuahua. The var. *ervoides*, apparently less frequently seen, is from Sinaloa and Jalisco. We thank E. Estrada with help in identification of this species to variety.

***Oxytropis lambertii* Pursh var. *bigelovii* A. Gray**. Chihuahua, Mpio. Progresso, vicinity of Yepomera, ca. 8 km S of junction of Madera – Peña Blanca road, 107°50'W, 27°02'N, elev. 1820 m. On whitish soil road bank and in field nearby; 19 Jun 1993, *Spellenberg, Brouillet,* and *Ulaszek 11910* (BRY, CIIDIR, MEXU, MT, NMC).

Apparent first record for Mexico; the species was not recorded for the country in Barneby (1952) nor in Welsh (2001).

LAMIACEAE

***Agastache pallidiflora* (Heller) Rydb. subsp. *pallidiflora* var. *gilensis* R. Sanders**. Chihuahua, Mpio. de Madera, 3 road km NE of small rancho called "La Tablita," 32 rd km SW of Rio Sirupa, ca. 45 air km. SSW of Madera, 28°55'45.1"N, 108°22'23.4"W; elev. 1755 m, N-facing slope in *Quercus arizonica, Arbutus arizonica,* pine woods, with *Cupressus* in canyon bottom. Corolla rose-pink, calyx green, tipped with pink; 28 Sep 2008, *R. Spellenberg and W. Anderson 14023* (CIIDIR, NMC).

Apparent first record for species for Chihuahua, first record for variety from Mexico. Sanders (1987, fig. 87) mapped only one record of this species for Mexico, that of var. *havardii* (A. Gray) Sanders from nw Coahuila. Var. *gilensis* is otherwise known from western New Mexico and southeastern Arizona.

PAPAVERACEAE

***Corydalis micrantha* (Englem.) Gray subsp. *micrantha*.** Chihuahua, Mpio. Guerrero, Chih. Hwy 25 1 km S of Rancho Blanco, 56 km N of Creel, 30 km S of jct with Mex. Hwy 16, 28°08'33.9"N, 107°29'24.3"W, elev. 2220 m; gravelly road bank in open woodland with *Juniperus deppeana, Quercus grisea, Pinus, Arctostaphylos.* Corolla dull pale yellowish, the upper lip burnished rusty orange adaxially; 5 Sep 2008, *R. Spellenberg* and *W. Anderson 14012* (BRIT, CIIDIR, MEXU, NMC, NY).

Apparent first record for Mexico. Neither Ownbey (1947) nor Stern (1997) recorded the species outside the central and south-central United States. The specimens key to this variety easily, the flower color matching that given in Ownbey except for the presence of a rusty orange blush on the upper petal of the flowers.

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FASCIATION OF MICROSPORANGIATE CONES OF *CYCAS REVOLUTA* (CYCADACEAE) IN AUSTIN, TEXAS

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ABSTRACT

Observations and photos of fasciated staminate cones of *Cycas revoluta* in Austin, Texas, are presented.

KEY WORDS: fasciated cones, *Cycas revoluta,* Cycadaceae

The present report was occasioned by the chance discovery of fasciated staminate cones on a plant of *Cycas revoluta* Thunberg (Cycadaceae) on the campus of the University of Texas, Austin, and the subsequent perusal of papers on the same subject — Lasley (2010) on Florida plants and Loeblich (2007) on Texas plants. The latter worker provided an excellent overview of fasciation in *C. revoluta*, this in connection with a plant from Galveston with five fasciated staminate cones, fully documented with appropriate photographs.

Austin material of such fasciation was first noted by the senior author in the spring of 2010 from a plant having six fused (or fasciated) cones occurring on the southern entrance to the UT campus, immediately adjacent to the Littlefield Memorial Fountain (Figs. 1, 2). Presumably, the phenomenon was due to a fasciated stem apex, as discussed by Loeblich. As to the cause of such fasciation, there is considerable controversy. Some workers attribute the anomaly as arising from some mechanical alteration at the apical meristem, noting that seemingly normal meristem producing staminate cones one year may give rise to fasciated cones the next (Loeblich 2007). Indeed, Loeblich opined that periodic wind forces along the Gulf Coast of Texas induced the fasciation found on plants at Galveston Island. Lasley, however, thought that an unseasonably cold winter in Florida induced the phenomenon.

The fasciation of *Cycas revoluta* reported in the present paper seemingly arose spontaneously, this from a normal apical meristem, as judged by the appearance of a single microsporangium at that position in 2009, this collected by the senior author, but only after several days of wrestling with an immature sporangium that finally yielded its trophy. In short, the physical efforts of cone removal the previous year possibly triggered the fasciation documented in the next. Fasciation (also referred to as cristation) is known to occur in various families and is generally thought to involve cytokinin balance.

The plant concerned will be re-examined in the spring of 2011 to see if it reverts to its normal cone-bearing condition or has been permanently embossed with its newly fasci(n)ated state.

ACKNOWLEDGEMENTS

Many thanks to Nancy Elder, Life Sciences Librarian at The University of Texas, for help in procurement of literature and to Guy Nesom and Jana Kos for helpful suggestions on the manuscript itself

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Figure 1. *Cycas revoluta* on the University of Texas campus, 30 June 2010.

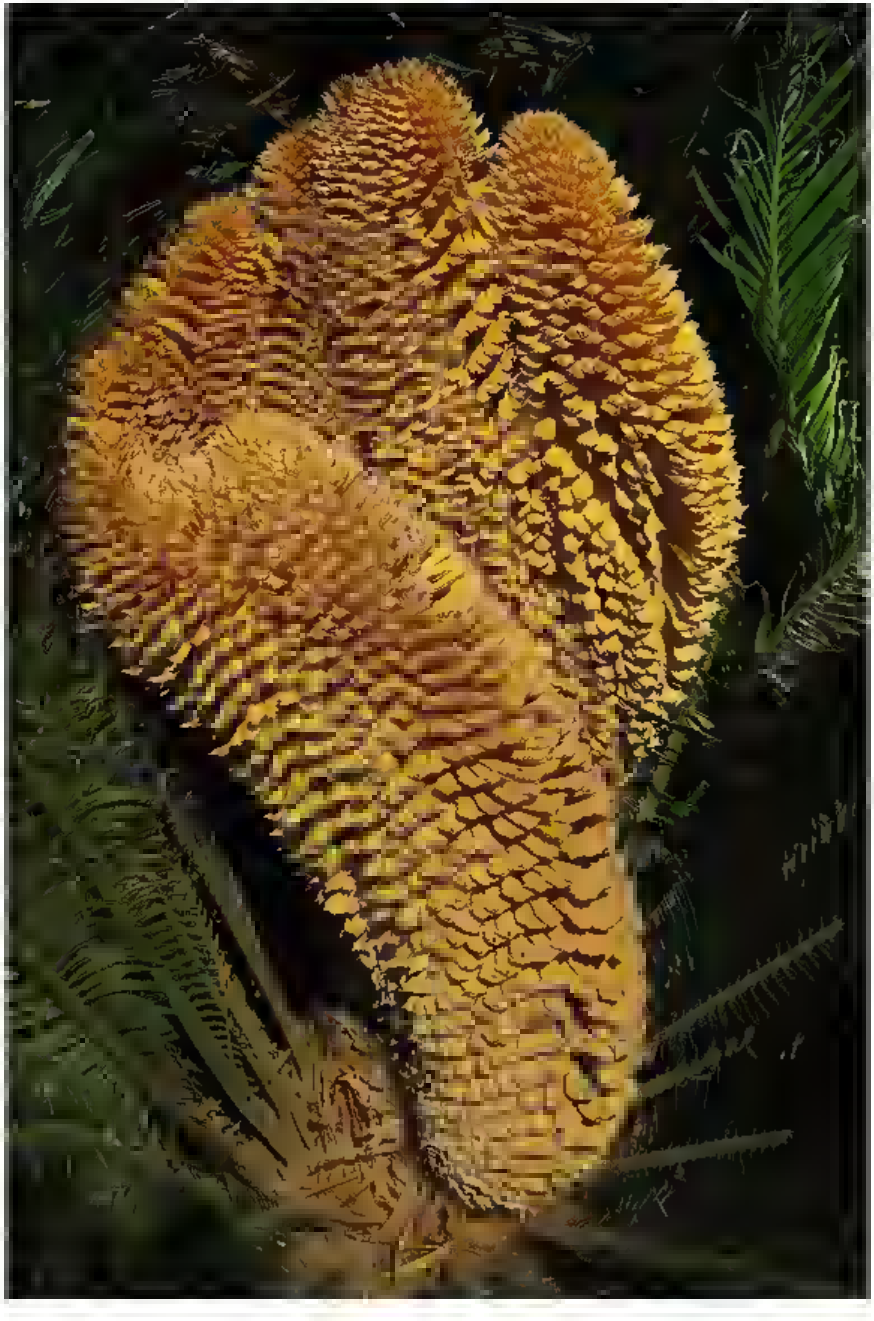

Figure 2 *Cycas revoluta* six fasciated cones 15 June 2010

Nesom, G.L. 2010. *Erigeron pumilus* and *E. concinnus* (Asteraceae: Astereae) in Colorado, New Mexico, and Arizona. Phytoneuron 2010-24: 1–5.

DISTRIBUTION OF *ERIGERON PUMILUS* AND *E. CONCINNUS* (ASTERACEAE: ASTEREAE) IN COLORADO, NEW MEXICO, AND ARIZONA

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ABSTRACT

The geographic ranges of *Erigeron pumilus* var. *pumilus* and *E. concinnus* are essentially parapatric in Colorado, northwestern New Mexico, and adjacent Arizona. The two taxa flower at the same time and occur in similar habitats, but putative morphological intermediates are rare. Their close, non-overlapping distribution is analogous to that of *E. pumilus* var. *intermedius* and *E. concinnus* in Nevada.

KEY WORDS: *Erigeron pumilus* var. *pumilus*, *E. concinnus*, Astereae, Colorado, New Mexico, Arizona

A sharp morphological and geographical demarcation in Nevada between *Erigeron concinnus* (Hook. & Arn.) Torr. & Gray and *E. pumilus* Nutt. var. *intermedius* Cronq. was regarded as evidence that the taxa are reproductively isolated, the former thus appropriately treated at specific rank (as *E. concinnus*, rather than *E. pumilus* var. *concinnoides* Cronq.; Nesom 1983).

Erigeron concinnus along its eastern border approaches the range of typical *E. pumilus*, and Cronquist noted (1947, p. 183) that these two "behave almost if not quite as distinct species, where their ranges meet." Harrington (1954, 570) also was aware of their distinction, noting that typical *E. pumilus* in Colorado was "all east of the Continental Divide," while *E. concinnus* was known from records "scattered in the western one-fourth [of the state]." The current study examines examines in detail the distributions and potential interaction between these two taxa, paralleling the earlier study (Nesom 1983) of *E. concinnus* and *E. pumilus* var. *intermedius*.

The three taxa under consideration are distinguished by contrasts in the following key (modified from Nesom 2006).

1. Disc corollas hirsute-strigose with sharp-pointed hairs; outer pappus of scales 0.2–0.5 mm long, inner of (7–)10–14(–15) bristles ..... **Erigeron concinnus**
1. Disc corollas glabrous or slightly puberulent with glandular-viscid, blunt-tipped hairs; outer pappus of setae or subulate scales, 0.1–0.3 mm, inner of 12–27 bristles ..... **Erigeron pumilus**

2. Outer pappus of coarse bristles or setiform scales, inner of 12–20 bristles; rays usually pink, sometimes white; indurate portion of disc corollas glabrous or slightly puberulent, relatively dull ..... **Erigeron pumilus** var. **intermedius**
2. Outer pappus of inconspicuous, well-developed setae, inner of 15–27 bristles; rays white; indurate portion of disc corollas glabrous, shiny ..... **Erigeron pumilus** var. **pumilus**

Figure 1 shows the total geographical distributions of *Erigeron concinnus* and the two varieties of *E. pumilus*, as currently understood.

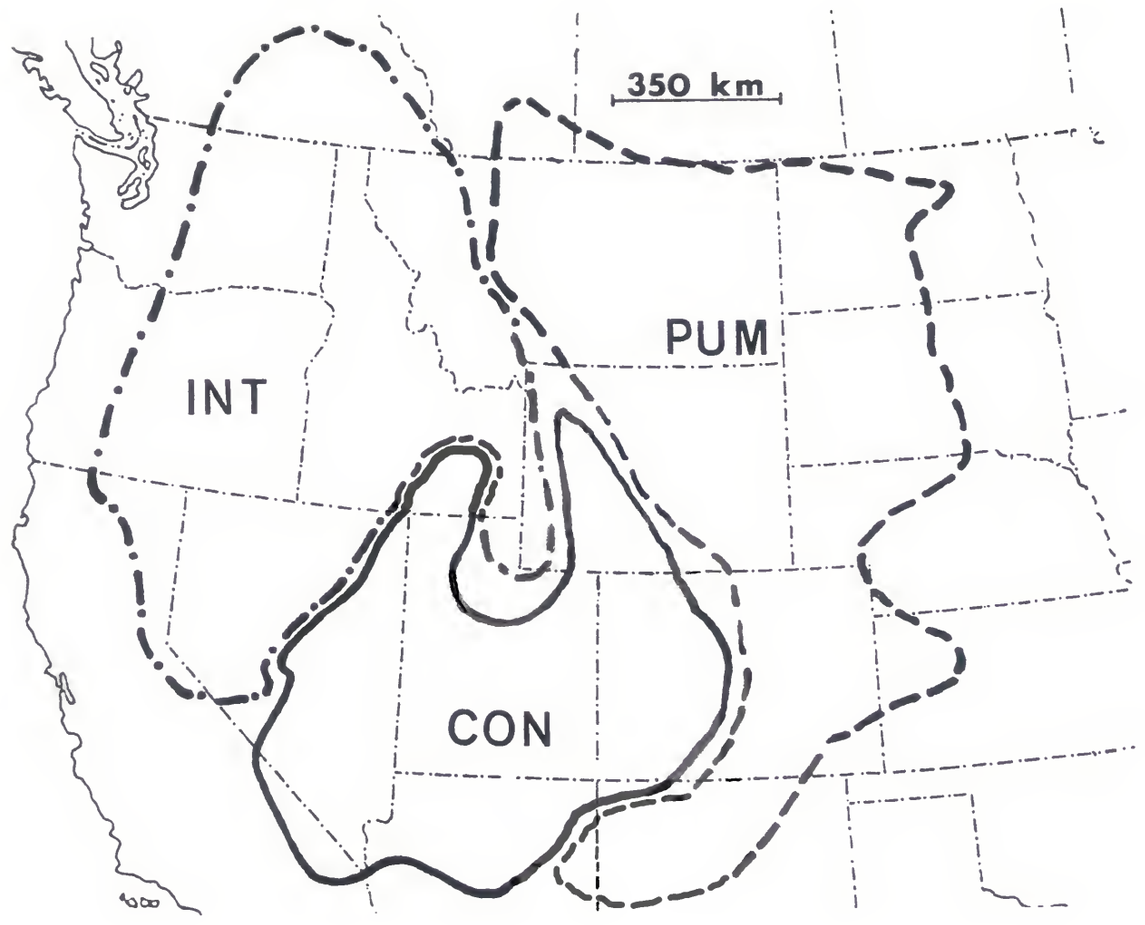

Figure 1. Generalized distributions of *Erigeron concinnus* (CON), *E. pumilus* var. *pumilus* (PUM), and *E. pumilus* var. *intermedius* (INT). Modified from Figure 1 in Nesom (1983), with var. *pumilus* now shown extending south into New Mexico and Arizona and further north in Wyoming.

The present study is primarily based on specimens examined from BRIT-SMU, NY, TEX-LL, and UNM (herbarium visits) and NMC and SJC (loans). The online specimen database from herbarium COLO has been used to complete Colorado distributions; recorded annotations by W.A. Weber usually indicate the nature of the outer pappus ("outer pappus of scales" = *E. concinnus*, or "outer pappus of bristles" = *E. pumilus*). Vouchers for New Mexico and Arizona are cited; those for Utah and Colorado are from BRIT, NY, SJC, TEX, and Cronquist (1947).

Results and discussion.

The geographic relationship of *Erigeron concinnus* with *E. pumilus* var. *pumilus* is analogous to its relationship with *E. pumilus* var. *intermedius*. *Erigerons concinnus* and var. *pumilus* are essentially parapatric in Colorado, New Mexico, and Arizona (Fig. 2), as are *E. concinnus* and var. *intermedius* in Nevada. In northwestern New Mexico, where the two taxa occur in closest proximity, intermediates are uncommon to rare (see below), suggesting that some degree of reproductive isolation exists. The same pattern of parapatry continues northward through Wyoming (see Rocky Mountain Herbarium 1998, with some modifications in identifications, fide Ron Hartman).

In documentation of the closely associated ranges in new Mexico, specimens studied from that state are cited here (Appendix 1). Because the occurrence of typical *Erigeron pumilus* in Arizona has been uncertainly known, records for it also are cited here (Appendix 2).

The close parapatry of *Erigeron concinnus* with the two expressions of *E. pumilus* is remarkable. In San Juan and Rio Arriba counties, New Mexico, where *E. concinnus* and var. *pumilus* closely approach each other, the San Juan River roughly marks a boundary between them but they flower concurrently and grow in similar habitats and an ecological factor that might be responsible is not apparent. Competitive exclusion seems unlikely.

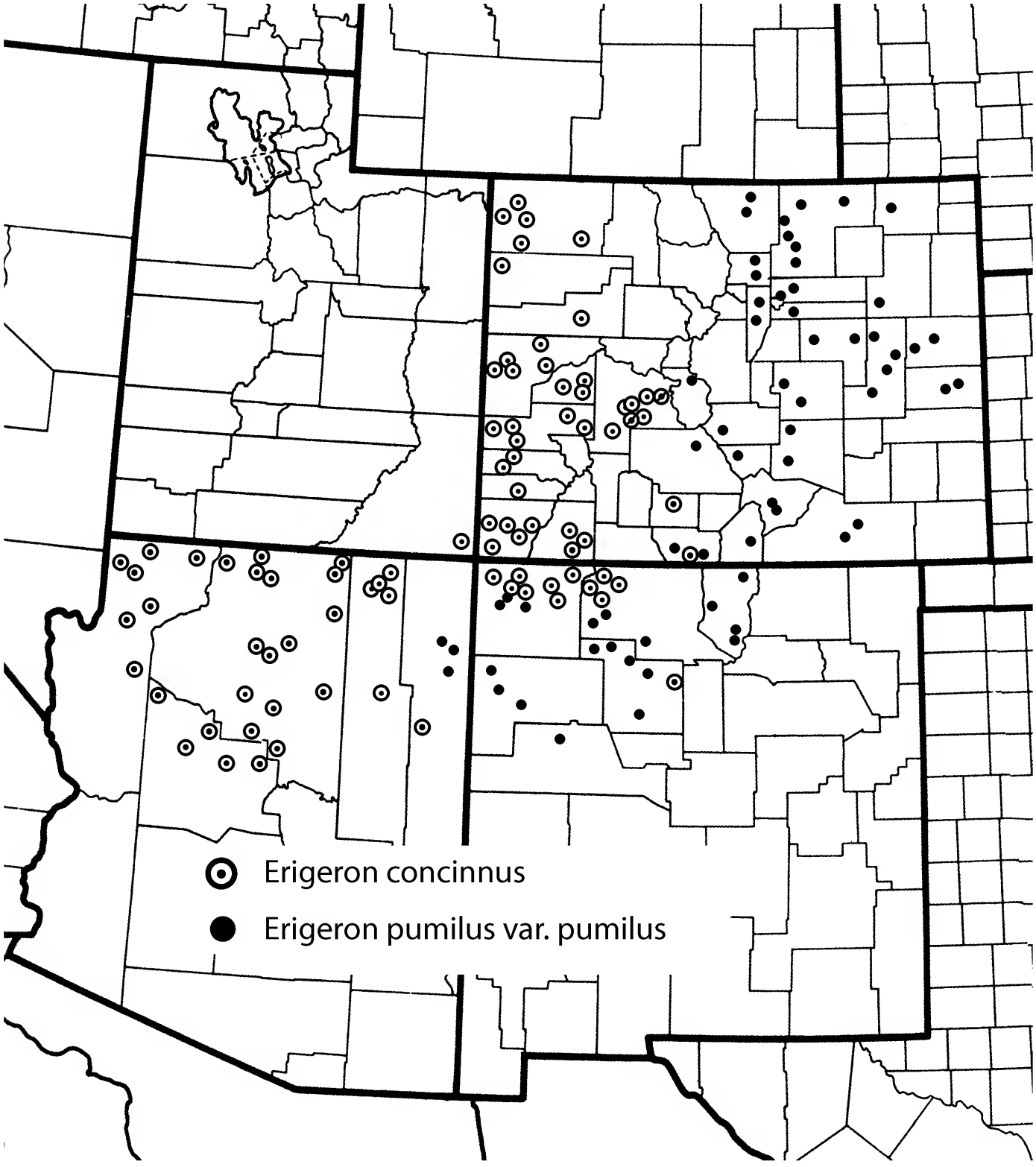

Figure 2. Geographic distribution of *Erigeron pumilus* var. *pumilus* and *E. concinnus* in Colorado, New Mexico, and Arizona. The slashed *E. concinnus* symbols in Gunnison Co., Colorado, are plants with very narrow scales. The out-of-range collection of *E. concinnus* from along the Rio Grande River in Sandoval Co., New Mexico (*Heller 3632*), possibly was a waif.

A chromosome number of $2n = 18$ has been reported for *Erigeron concinnus*, $2n = 18$ and $2n = 36$ for var. *intermedius*. Apparently no report exists for var. *pumilus*. In any case, it would not be surprising to find more than one ploidy level in each of the three, given the high frequency with which polyploidy occurs in the genus, and a cytological study might provide useful biological insights. Even if different ploidal races were parapatrically aligned, however, it seemingly would not account for the sharp boundaries.

ACKNOWLEDGEMENTS

I am grateful to SJNM and NMC for loans of specimens and to BRIT, NY, TEX, and UNM for hospitality during study there. Ken Heil provided precise information on New Mexico localities.

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Appendix 1. *Erigeron concinnus* and *E. pumilus* var. *pumilus* in New Mexico.

Erigeron concinnus. Rio Arriba Co.: BLM, near Gobernador, along gas line N of the El Cedro Compression Station, ca. 1 mi NW of the Gobernador Camp, sagebrush with scattered juniper, 18 May 1993, *Heil & Melton 7484* (SJC); Delasso Loos Road, 9.3 mi E of NM 539, large old pinyon-juniper woodland, Russian olive, rabbitbrush, and willow, gray clay soil, 1 Jun 1997, *Reeves 9308* (SJC); mouth of Cottonwood Canyon, Lower Bancos Canyon, pinyon-juniper, clay to sandy soil, 1950 m, 28 May 1987, *Wilken 14739* (NMC). Sandoval Co.: 19 mi W of Santa Fe, along banks of the Rio Grande River, 5450 ft, 31 May 1897, *Heller 3632* (MO, NY). San Juan Co.: Aztec, 28 Apr 1899, *Baker 664* (MO, NY, RM, US, fide Cronquist 1947); B-Square Ranch, Head Canyon ca. mi S of outlet, talus, 5340 ft, 25 May 1999, *Heil 13011* (SJC); Bloomfield, N of town on "B" Hill, 9 May 1982, *Howd 16*[2032] (SJC); The Badlands, W of Farmington, ca. 1 mi W of the La Plata River, 23 May 1984, *Porter 84-214* (SJC); Bloomfield [area], N side of Kutz Canyon, 3 May 1985, *Porter 1018* (SJC); Co. Rd. 3590, 1.8 mi N of NM 574, jct 5 mi NW of Aztec, badland ridges, open pinyon-juniper woodlands, 6260 ft, 17 Jun 1997, *Reeves 9403* (SJC); Pump Mesa, access from NM 511, gas well 236, pinyon-juniper woodland, sandy clay soil, 17 May 2000, *Reeves 10090* (SJC); Farmington, 19 Jun 1911, *Standley 7096* (US, fide Cronquist 1947).

Erigeron pumilus var. **pumilus**. McKinley Co: ca. 6 mi W of Torreon and ca. 2.5 mi E of Ojo Encino, desert shrub community, silty-clay, ca. 5700 ft, 6 May 1995, *Clifford 95-117* (SJC); Navajo Nation, 4.5 mi E of Coyote Canyon community [Brimhall P.O.], scattered juniper, big sagebrush, rabbitbrush, 6630 ft, 17 May 2000, *Clifford 00-249* (SJC); Navajo Indian Reservation, just W of Ojo Encino School in sagebrush flats, sandy-clay soil, 6800 ft, 30 Jun 1988, *Heil 4486* (SJC); Navajo Nation, 1.5 mi down Wildberry Canyon [ca. 5 miles ESE of Coyote Canyon Store], savannah with pinyon, juniper, ephedra, Yucca, sandy, 7066 ft, 17 May 2000, *Heil et al. 14579B* (SJC); N of Continental Divide community, pinyon-juniper, red sand with gypsum, 7500 ft, 12 Jun 1991, *Hevron*

1258 (TEX); NW of Ojo Encino near the Continental divide, sagebrush flat, 2127 m, 24 May 2000, *O'Kane & Heil 4635* (SJC). Rio Arriba Co: ca. 0.5 mi N of jct Forest Service Roads 314 and 315, Carson National Forest, Jicarilla District [ca. 13 miles S of US 64 and ca. 1 mile E of the Jicarilla Apache Reservation, ca. 25 miles SSE of Navajo City], ponderosa pine, juniper-oak, 9 Jun 1995, *Clifford 115* (SJC); Navajo Canyon, 4.5 mi SW of Canjilon, sagebrush-Pinus edulis, 7400 ft, 14 Aug 1963, *Goodrow 694* (UNM); Largo Canyon Road near mouth of Rincon Largo, slopes above the wash and in wash, clay soils on slopes above and sandy alkaline soils in wash, 1936 m, 5 Jun 2000, *Heil & O'Kane 14731* (SJC); Jicarilla Apache Reservation, Largo Canyon, Adobe Knobs area, 1 mi E of NM 537, ca. 6 mi S of 6th Std. Parallel North, pinyon-juniper community, clay, 18 May 1995, *Holmes 93* (SJC). Sandoval Co.: Jicarilla Apache Reservation, road across from rest area at jct 537 and 44, first dirt road to left, ca. 1 mi, 6 Jun 1995, *Holmes 296* (SJC); Mule Dam area, desert scrub community, 6 Jun 1995, *Holmes 313* (SJC); exactly 20 NW of Cuba along NM Hwy 44, , ca. 1/2 mi E of NM 537 (Lindrith/Duke road), 1/4 mi S of hwy, S side of mesa, on S slope over badlands, *Artemisia tridentata*, in sand, 4 Jun 1984, *Spellenberg 7792* (NY, TEX); NM Hwy 44, 20 NW of Cuba, ca. 1/2 mi S of hwy on W side of mesa, between badland ridges and extending weakly into loamy, alkaline soil, among sagebrush, 7000 ft, 29 May 1986, *Spellenberg 8490* (NY, TEX). San Juan Co.: Dufer's Point, 10 mi NE of Huerfano Mt., sagebrush community, with *Hilaria jamesii*, *Bouteloua gracilis*, *Artemisia tridentata*, loamy clay soil, 1981 m, 26 Apr 1987, *Anderson 4114* (NMCR); 1.0 mi W of Chuska Peak, ponderosa pine-oak-juniper, gravelly soil, 4 Jun 2001, *Atwood & Clifford 27599* (SJC); Navajo Reservation, 6.5 mi SW of Nageezi area, shallow sloping topography above Kimbeto Wash, scattered pinyon-juniper, eolian deposited sand sheet, ca. 6900 ft, 25 May 2000, *Clifford 00-354* (SJC); Navajo Nation, Tertiary terrace 1.5 mi SW of San Juan River-Hogback Monocline crossing, galleta and Indian rice-grass community, silty to sandy soil, 5170 ft, 11 Jul 2000, *Clifford 00-738* (SJC); Cutter Dam, 4 Jun 1995, *Holmes 285* (SJC); San Juan College [Farmington], Fred Edwards Nature Trail, pinyon-juniper woodland, alluvium, 5700 ft, 4 May 1988, *Jenkins & Smith 45* (SJC); Navajo Indian Reservation, NIIP, S13 T27N, R16W [ca. 28 miles WNW of Farmington], desert shrub, 1 Jul 1988, *Mietty 3114* (SJC); BLM, Angel Peak area S of Bloomfield, sagebrush community, sandy soil, 6185 ft, 19 May 1992, *Sawyer 45* (SJC). Taos Co.: 18 mi S of Ranchos de Taos on Hwy 68 at historical marker, 8 Jun 1979, *Holm 16* (BRIT); 5.9 mi W of Penasco on Hwy 75, 8 Jun 1979, *Pierce 12* (BRIT); N of Arroyo Aguaje de la Petaca, among sagebrush along power line, 31 May 1978, *Spellenberg 4986* (NMC, NY).

Appendix 2. *Erigeron pumilus* var. *pumilus* in Arizona.

Erigeron pumilus var. **pumilus**. Arizona. Apache Co.: Navajo Reservation, W Chuska Mtns., ca. 2.25 mi E of Wheatfields Lake and 1.5 mi NE of White Cone Peak [New Mexico], ponderosa pine with big sage, silty clay to silt, 7850 ft, 4 Jun 2001, *Clifford & Atwood 01-596* (SJC); Defiance Plateau, 7 Jun 1937, *Peebles & Smith 13446* (LL, US fide Cronquist 1947); Canyon de Chelly National Monument, west shore of Tsaile Lake on gravelly, sandy soil, 23 May 2001, *Rink 421* (SJC).

TAXONOMY OF THE *VERBENA CALIFORNICA* GROUP (VERBENACEAE)

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ABSTRACT

Verbena californica (California) and *V. orcuttiana* (Baja California) are hypothesized to be sister species and constitute *Verbena* series *Californicae*. Descriptions and typifications are provided for both and a map shows their relative distributions.

KEY WORDS: *Verbena californica*, *V. orcuttiana*, *Verbena* series *Californicae*, Verbenaceae

Verbena californica Moldenke and *V. orcuttiana* Perry are narrow endemics (Fig. 1) that are hypothesized here to be sister species. Both are taptooted perennials, with elongate, epetiolate, and regularly coarsely crenate to serrate but unlobed leaves; fruiting spikes are few from medial to distal branches and the fruits become remote; rachises and calyces are glandular; and commissural faces of the nutlets extend completely to the nutlet tips.

Verbena californica and *V. orcuttiana*, with *V. abramsii* Moldenke, were recognized as series *Californicae* (Nesom 2010a), but *V. abramsii* proves to be most closely related to *V. lasiostachys* Link (Nesom 2010b). The Californian sisters are similar in aspect to some species of ser. *Tricesimae* — their recognition as a separate group emphasizes their distinctive nutlet morphology and their similar geography.

KEY TO THE SPECIES

1. Distal cauline leaves often subclasping; stems densely bristly-hirsute to hirsute-villous, stipitate-glandular; California ..... **Verbena californica**
1. Cauline leaves not subclasping; stems glabrous or glabrate to sparsely hirsutulous or hirsutulous-hirtellous, eglandular to sparsely glandular; Baja California ..... **Verbena orcuttiana**

VERBENA CALIFORNICA Moldenke, Known Geogr. Distr. Verbenaceae and Avicenniaceae, 79. 1942. **TYPE: USA. California**. Tuolumne Co.: 3 mi N of Keystone, 30 Sep 1938, *R.F. Hoover 3870* (holotype: JEPS 3403-digital image!, NY-photo!; isotypes: NY! ("fragment of type, herb. U. of Calif.")-digital image!, UC 213708, digital image!, US-digital image!). Annotations of the JEPS and UC specimens by G. Thomas Robbins note that "The original description states that the type of the species 'is deposited in the herbarium of the University of California at Berkeley.'" The JEPS sheet was annotated in February 1942 by Moldenke as "TYPE!;" the UC specimen was not annotated by Moldenke. The US specimen was annotated in 1982 by Moldenke as an "isotype."

Plants perennial herbs, taprooted. **Stems** 1–3 from the base, decumbent-ascending to erect, 30–75 cm, densely bristly-hirsute to hirsute-villous, stipitate-glandular. **Leaves**: basal and lower cauline persistent, (proximal and medial) mostly oblanceolate but also to elliptic-oblanceolate or oblong-oblanceolate, proximal and midstem blades 3–8(–9) cm x 6–25 mm, relatively even-sized or quickly becoming narrower (narrowly oblong-oblanceolate to oblong-oblanceolate) distally and subentire, veins slightly impressed adaxially, margins coarsely serrate to serrate-crenate or subentire, both surfaces hirsute to hirsute-strigose or hirsute-villous, sparsely stipitate-glandular; sessile to subsessile, distal usually subclasping. **Fruiting spikes** 1 or 3(–5) from distal branches, open and relatively slender (fruits not overlapping or only slightly), 6–20(–25) cm; floral bracts ovate-

triangular to triangular-lanceolate, 3.5–4 mm, equal or slightly shorter than the calyces. **Calyces** 3.5–4 mm, hispid-hirsute, lobes triangular, not connivent. **Corollas** violet to pale purple or white with pink tubes, tubes 4.5–5 mm, 1–1.5(–2) mm longer than the calyces, limbs 3–4.5 mm in diam. **Nutlets** 1.8–2.1 mm, easily separating, commissural faces reaching the nutlet tips, bare or sparsely bullate with filiform plates.

Flowering May–Sep. Wet places, seeps, creek edges, stream beds, oak and pine-oak woodlands, serpentine soils; 300–400 m elevation.

Verbena californica is a California endemic known only from the serpentine soils of the Red Hills in western Tuolumne County. The plants are characterized by large, subclasping cauline leaves, bristly-hirsute and stipitate-glandular stems, glandular calyces, and relatively large flowers.

Collections examined. **USA. California**. Tuolumne Co.: 1.5 mi SW of Chinese Camp, 19 Jun 1938, *Hoover 3613* (NY); W base of Taylor Hill, S of Chinese Camp, in wet soil along stream, serpentine rock, 23 Jun 1966, *Hoover 9885* (NY); moist rock, serpentine soil in a stream bed crossing Redhills Rd (Sims Rd cont.) 1.7 mi S of Hwy 120 between Yosemite Jct and Chinese Camp, 23 May 1972, *McNeal 925* (NY); 2 mi S of Chinese Camp on Six Bit Creek, streambed in dry drassland and chaparral, 10 Jun 1970, *A.R. Moldenke 3397* (LL-2 sheets); Chinese Camp, along small brook, 19 Jun 1972, *A.R & H.N. Moldenke 25758* (LL, MO). Data from numerous collections, with photos of nine of the specimens, are provided in the Calflora Database (2010); a Calflora georeferenced map includes 26 points. All populations apparently occur within an area of 15–20 square miles.

VERBENA ORCUTTIANA Perry, Ann. Missouri Bot. Gard. 20: 284. 1933. **TYPE: Mexico. Baja California**. Hanson's Ranch, table lands, 6000 ft, 30 Jul 1883, *C.R. Orcutt 909* (holotype: GH digital image!; isotypes: F-2 sheets digital image!, NY! digital image!).

Plants perennial herbs, taprooted. **Stems** ca. 3–5 from the base, decumbent-ascending to erect, 40–70 cm, glabrate to very sparsely hirsutulous, eglandular. **Leaves**: basal and lower cauline persistent, (basal and medial) oblong-oblanceolate to lanceolate, oblanceolate, or narrowly oblanceolate, not lobed, gradually tapering to a petiolar region, veins impressed adaxially, margins coarsely to shallowly serrate with 5–8(–9) teeth per side, narrowly revolute, midstem blades mostly 4–6 cm x 4–8 mm, relatively even-sized to near midstem, becoming sublinear and subentire distally, not subclasping, hirsute-strigose and sparsely stipitate-glandular abaxially, hirsute-strigose adaxially. **Fruiting spikes** 1 or 2–5 from medial to distal branches, moderately dense with overlapping fruits but loosening in the proximal half and fruits becoming slightly remote, 6–30 cm; floral bracts lanceolate-acuminate, 2.5–3 mm, equal or slightly shorter than the calyces. **Calyces** 3.5–4 mm, short-strigose to hirsutulous-strigose, sessile- to short-stipitate-glandular, lobes deltate-triangular to ovate-lanceolate, not connivent to subconnivent. **Corollas** blue to violet, tubes 4–4.5 mm, 1–1.5 mm longer than the calyces, limbs 3–4 mm in diam. **Nutlets** ca. 2 mm, easily separating, commissural faces extending completely to the nutlet tips, densely white-bullate-papillate.

Flowering Jul–Sep. Open pine woods, dry meadows; ca. 1500–2000 m.

Additional collections. **Mexico. Baja California**. Sierra Juarez, 12 Jul 1924, *Gallegos 2342* (US fide Perry); Sierra Juarez, locally common in dry meadow, 3.5 road mi W of Rancho la Botella [31° 57' N, 115° 53' W], 1700 m, 25 Sep 1966, *Moran 13604* (LL, MO, NY); Sierra Juarez, common under pine, La Sierrita NW of Laguna Hanson [32° 05' N, 115° 55.5' W], 1700 m, 1 Aug 1976, *Moran 23709* (LL); Sierra Juarez, common with *Artemisia tridentata* in open Jeffrey pine forest, 5 km N of Laguna Hanson [32° 05' N, 115° 54' W], 1650 m, 24 Jul 1977, *Moran 24339* (LL); Pinery, 27 Jul 1883, *Orcutt s.n.* (US fide Perry); Hanson's Ranch, 29 Jul 1883, *Orcutt s.n.* (GH, NY, US fide Perry); Cantilas Mts., Lower Calif., Jul 1883, *Orcutt s.n.* (NY); mountains, northern Lower California, 8 Jul 1885, *Orcutt s.n.* (US fide Perry).

Verbena orcuttiana apparently is endemic to the Sierra Juarez of Baja California, where it is known from about 31° 57'–32° 10' N and 115° 49'–53' W. Most collections are from the area of Laguna Hanson, now in El Parque Nacional de Constitución de 1857.

Proposed treatment of *Verbena orcuttiana* as a variety of the eastern North American *V. simplex* Lehm. (O'Leary et al. 2010, in press) refers to Perry's observation (1933, p. 285) that "In gross habit, [*V. orcuttiana*] is scarcely to be distinguished from *V. simplex*, but the latter has somewhat harsher pubescence and larger non-glandular flowers." O'Leary et al concur but consider that "estos characteres no son lo suficientemente importante como para sostener una species."

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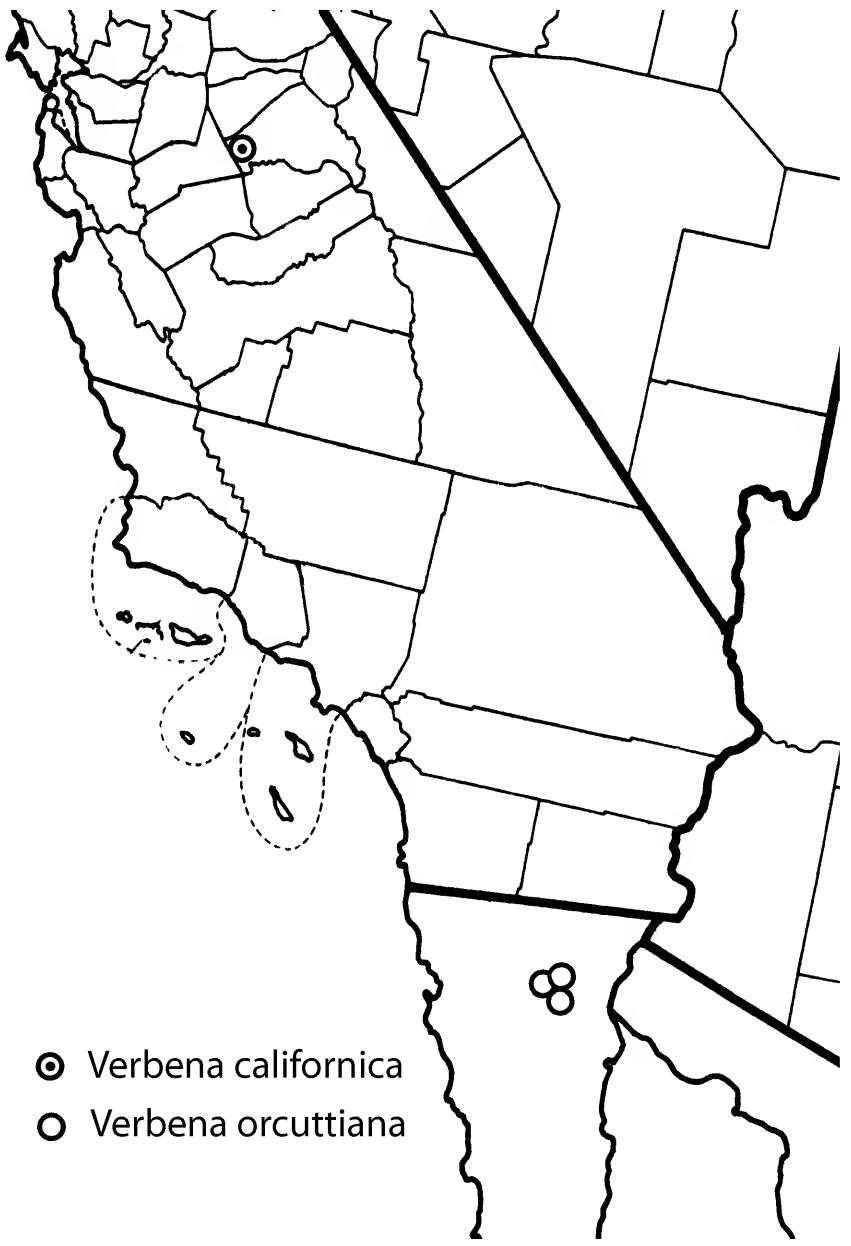

Fig. 1. Distribution of *Verbena californica* and *V. orcuttiana*. Their distributions are separated by about 850 kilometers.

IS *VERBENA ABRAMSII* DISTINCT FROM *V. LASIOSTACHYS* (VERBENACEAE)?

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ABSTRACT

The question is posed but not unequivocally answered. Plants identified as *Verbena abramsii* appear to be consistent in morphology and a mostly restricted to southernmost California counties. On the other hand, the limited sampling in the present study does not provide confidence that *V. abramsii* represents no more than extremes of populational variability within the widely ditributed *V. lasiostachys*, with which it is sympatric. As a hypothesis to encourage more detailed study, *V. abramsii* is tentatively accepted here, and its description is drawn from the specimens studied.

Verbena abramsii Moldenke has been treated as a distinct species, an infraspecific entity within *V. lasiostachys* Link, and simply as a synonym of *V. lasiostachys*. *Verbena lasiostachys* is morphologically variable and has a wide geographic range, and its nomenclatural history and variability are first considered in the assessment of the status of *V. abramsii*.

Overview of *Verbena lasiostachys*.

Within *Verbena lasiostachys*, variation in habit (erect to prostrate), leaf size (small to large or 'robust'), calyx length, and leaf vestiture has been the primary basis of formal recognition of varieties and segregate species. Apparently, however, there exists in literature not even a critical commentary on the patterns of variation, and there has been no consistent agreement on which taxa have biological reality or at what rank to treat putative variants. Floristic treatments usually have included included only a statement of geographic range and a diagnostic phrase or sentence regarding morphological distinctions.

Two venerable names are at the heart of the issue: *Verbena lasiostachys* Link from 1822 and *V. robusta* Greene from 1898. Others were later added by Moldenke (below). Perry (1933) recognized typical *V. lasiostachys* (using the name *V. prostrata*, which proved to be a later homonym) as well as *V. robusta*, noting that the latter "is quite readily distinguished … by the brighter green color of the herbage, the scabrous upper surface of the leaves, and the usually dense spikes. Moreover, the mature calyx lacks the marked tendency toward subconnivent lobes, a characteristic of [*V. lasiostachys*]."

Moldenke (1940) described two infraspecific taxa within *Verbena lasiostachys* (var. *septentrionalis* Moldenke and var. *scabrida* Moldenke) and the segregate species *V. abramsii* Moldenke. His concepts were largely typological and in 1979 he reduced the rank of both varieties to "forma," without providing comment or rationale.

Jepson (1943) recognized *Verbena robusta* as a distinct species and included Moldenke's two varieties as synonyms of typical *V. lasiostachys*. He reduced *V. abramsii* to varietal rank within *V. lasiostachys*.

Abrams (1951) distinguished *Verbena lasiostachys* var. *septentrionalis* as "the prevailing form in Oregon and in the North Coast Ranges and the Sierra Nevada to Kern County" but included *V. robusta* within typical *V. lasiostachys*. He recognized *V. lasiostachys* var. *abramsii*, noting (p.

611) that "This form, described originally from San Diego County, occurs also in the southern Sierra Nevada, and on the desert slopes of the mountains of southern California, especially of the San Gabriel and San Bernadino Ranges."

Munz and Keck (1959) treated *Verbena robusta* Greene as a distinct species from "Marin and Tuolumne cos. to San Diego Co.; n L. Calif.," based on the distinctions in his associated key and geographical summaries.

1. "Spikes 0.3–1 dm long in fr., lvs. bright green, scabrous above, inner face of nutlets with whitish papillae; Marin and Tuolumne cos. to San Diego Co., n. L. Calif." ..... **Verbena robusta**
1. "Spikes 1–3 dm long in fr.; lvs. canescent, not scabrous above, inner face of nutlets without whitish papillae, most of cismontane Calif., to Ore., n. L. Calif." ..... **Verbena lasiostachys**

Using essentially the same contrast as Munz and Keck, Wilken (1993) also recognized two entities within the *Verbena lasiostachys* complex but treated them at varietal rank: *V. lasiostachys* var. *lasiostachys* (including *V. abramsii* as a synonym) and var. *scabrida* (including *V. robusta* as a synonym). He noted that the "Vars. need further study."

O'Leary et al. (2010) regard *Verbena lasiostachys* as broadly defined (including *V. robusta*) and without formal infraspecific variants. They place *V. abramsii* as a synonym of *V. neomexicana* var. *hirtella* Perry, an entity mostly of Texas and southern Chihuahua (not reaching New Mexico, Arizona, California, Sonora, or Baja California).

VERBENA LASIOSTACHYS Link, Enum. Hort. Berol. Alt. 2: 122. 1822. TYPE: Link's protologue noted only "Habitat in California." **NEOTYPE TO BE DESIGNATED** (O'Leary et al. 2010): **USA. California**.

Verbena prostrata R. Br. in W.T. Aiton, Hort. Kew. ed. 2, 4: 41. 1812 (not *V. prostrata* G. Savi 1802). **TYPE** (the protologue): "*Nat.* of the North West Coast of America. *Archibald Menzies*, Esq. *Introd.* 1794. *Fl.* June and July" (holotype: K?).

Verbena robusta Greene, Pittonia 3: 309. 1898. TYPE: **USA. California**. Marin Co.; Point Isabel E shore and Pt. Tiburon, 20 Jul 1891, *E.L. Greene s.n.* (holotype: ND-G, fide O'Leary et al. 2010).

Verbena lasiostachys var. *septentrionalis* Moldenke, Amer. Midl. Naturalist 24: 753. 1940. *Verbena lasiostachys* forma *septentrionalis* (Moldenke) Moldenke, Phytologia 44: 328. 1979. **TYPE: USA. Oregon**. [Jackson Co.]: Near Medford, Aug 1922, *C.C. Epling 5445* (holotype: LA photo-LL!, photo-NY!).

Verbena lasiostachys var. *scabrida* Moldenke, Amer. Midl. Naturalist 24: 753. 1940. *Verbena lasiostachys* forma *scabrida* (Moldenke) Moldenke, Phytologia 44: 328. 1979. **TYPE: USA. California. Monterey Co.**: Monterey, [dry meadow], Aug 1917, *S.B. Parish 11590* (holotype: POM, photo-NY!; isotype: UC).

Verbena lasiostachys forma *albiflora* Moldenke, Phytologia 9: 465. 1964. **TYPE: USA. California. San Mateo Co.**: Portola Valley, 2 Jun 1914, *L. Abrams 5109* (holotype: DS, NY-photo!).

Plants perennial, taprooted. **Stems** 1–8 from the base, erect to ascending or decumbent ascending, often leaning, [procumbent or prostrate?], 20–100(–200) cm, hirsute to hirsute-villous, minutely stipitate-glandular. **Leaves** ovate or elliptic-ovate or obovate, basal and lower cauline deciduous by flowering or persistent, midstem blades 2–7 cm x 10–40 cm, greatly variable in size among plants, relatively even-sized along the stems, veins impressed adaxially, margins coarsely serrate to crenate, dentate, or incised-serrate, sometimes 3-lobed, hirsute adaxially, hispid to hirsute abaxially, stipitate-glandular; petioles 5–25 mm. **Fruiting spikes** 1 or 2–5 from distal branches, dense with overlapping fruits to somewhat looser, 5–15 cm; floral bracts triangular to linear-lanceolate or narrowly lanceolate 2–3 mm, usually shorter than the calyces; rachis glandular. **Calyces**

(3–)3.5–4 mm, longer than the nutlets, hirsute to hirsute-villous, minutely stipitate-glandular, lobes linear-lanceolate to narrowly lanceolate, narrowly oblong-lanceolate, or triangular, usually 2–3 times longer than the nutlets, connivent. **Corollas** blue to violet or purple, rarely red-violet, tubes 3.5–5 mm, 0.5–1(–2) mm longer than the calx, limbs 2–3.5 mm in diam. **Nutlets** 1.2–1.6(–1.8) mm, separating at maturity, commisural faces ending below nutlet tips or nearly to tips in smallest nutlets, sparsely to densely glandular-papillate (acicular), rarely bare. $2n = 14$.

Flowering (Apr–)May–Aug(–Sep). Open oak woods, grasslands, rocky hillsides, stream margins, marshy meadows, washes, gravel bars and alluvium, dried river beds, dunes, woodland edges, open fields, roadsides, disturbed sites; 100–1200(–1700) m; Calif., Oreg.; Mexico (Baja California).

A record of *Verbena lasiostachys* from New York cited by Mitchell (1986) and repeated in numerous databases was collected in Kings County in 1873 (Flora of Long Island, Brooklyn, Nostrand Avenue, 16 Sep 1873, *M. Ruger s.n.*, NY!), surely either as a garden plant or waif. This is probably the same record alluded to by Shreve and Wiggins (1964, p. 1242): "Introduced in New York." New York is far out of range and out of habit for *V. lasiostachys*, and it probably has never been a member of the New York flora.

Collections examined of *Verbena lasiostachys* from Mexico are cited here: **Baja California**. Rancho Cuevas, 7 km S of Rosarito, 32° 18' N, 117° 03' W, 10 m, colony in semi-shade on N bank above creek, 11 Jun 1980, *Moran 28754* (TEX); El Refugio, 8 km E of La Presa, 32° 27' N, 116° 48.75' W, one in arroyo with *Salix*, *Baccharis*, *Iva*, 140 m, 7 Jun 1981, *Moran 29601* (NY); Santa Tomas, 15 Jul 1885, *Orcutt 1301* (MO, NY); Mpio. Ensenada, Rancho "El Paraiso," 17 km SE of Maneadero, 31° 37' N, 116° 29' W, matorral esclerofilo, 150 m, 7 May 1987, *Tenorio 13408* (TEX); near Rancho Salina, foot of Guatay Grade, ca. 6 km S of Rio Guadalupe, 11 Sep 1929, *Wiggins & Gillespie 3977* (MO, NY).

Consideration of *Verbena abramsii*.

There is justification for regarding *Verbena abramsii* as one node of the variability within *V. lasiostachys*, which is an unusually variable species. Leaves of *Verbena abramsii* are similarly variable in size and shape, and as in *V. lasiostachys*, the flowers are small and the fruiting spikes remain relatively compact. Plants of *V. abramsii* appear to be consistently prostrate, but prostrate stems apparently occur also in typical *V. lasiostachys*.

Cauline vestiture of *Verbena abramsii* is near the first of two extremities of variability in *V. lasiostachys*: (1) hirsute to hirsute-villous with sharp-pointed, stiff to flexuous non-glandular hairs of uneven length and uneven orientation, sometimes also sparsely stipitate-glandular with short erect hairs and (2) stipitate-glandular with short to long flexuous hairs, without non-glandular hairs or with short non-glandular hairs.

Calyx lobes in *Verbena lasiostachys* are highly variable in length (2–3 times longer than the nutlets, linear-lanceolate to narrowly lanceolate or triangular), although longer lobes are perhaps modal. Moldenke noted that his *V. lasiostachys* var. *septentrionalis* was distinct from the typical form in its short calyces, "in all only 3–4 mm long." Even so, the calyx lobes of plants identified by Moldenke as var. *septentrionalis* are triangular and occur in plants otherwise typical of *V. lasiostachys*. Calyx lobes of *V. abramsii* are deltate to shallowly deltate and barely longer than the nutlets, in effect representing the extreme of reduction in length.

On the other hand, apparently consistent features of morphology and geography suggest that *Verbena abramsii* may be a distinct evolutionary entity. The habit is consistently prostrate, the stems are stiffly villous and essentially eglandular, flowering spikes tend to be thinner, and leaves narrower

than in *V. lasiostachys*. The most consistent diagnostic feature is the reduced calyx. Calyx variation in *V. lasiostachys* does not appear to have strong geographic correlations, but *V. abramsii* occurs mostly in the southernmost California counties (specimens examined here from San Bernadino, San Diego, and Los Angeles counties; see caveat below). Abrams (1951, p. 611) noted that *V. lasiostachys* var. *abramsii*, "described originally from San Diego County, occurs also in the southern Sierra Nevada, and on the desert slopes of the mountains of southern California, especially of the San Gabriel and San Bernadino Ranges."

In the protologue of *Verbena abramsii*, Moldenke (1940) did not cite specimens other than the type, but he noted (p. 751) that it is "also known from Inyo, Kern, Los Angeles, Mariposa, Monterey, Riverside, Sacramento, San Bernadino, and Tulare counties." In 1961, he cited specimens of *V. abramsii* from a wider range of counties: Fresno, Inyo, Lake, Los Angeles, Mariposa, Monterey, Orange, Riverside, Sacramento, San Bernadino, San Diego, San Joaquin, San Luis Obispo, Trinity, and Tulare. In Moldenke's concept, *V. abramsii* and *V. lasiostachys* apparently were broadly overlapping in geographic range.

The broader geographical concept of *Verbena abramsii* fide Moldenke may find support in an example here. In addition to the collection cited below as *V. abramsii* from Monterey County (*Howell 40039*), Howell made two others, identified here as *V. lasiostachys*, on the same day from the same general locality: Monterey Co.: Abbott Lakes, Arroyo Seco Forest Service Campground, 6 Aug 1963, *Howell 40043*, (LL), *40045* (LL). Stems of both *40043* and *40045* appear to be erect and both collections have calyces 3.5 mm long with narrowly oblong-lanceolate lobes; stems of *40043* are glandular only; stems of *40045* are hirsute-villous and glandular. Variation among these three collections mirrors the larger pattern within *V. lasiostachys*.

In summary, the geographic restriction of plants with a consistent set of features, especially the extremely reduced calyx, suggests that *Verbena abramsii* may be a real entity. On the other hand, the limited sampling in the present study does not provide confidence that *V. abramsii* represents no more than extremes of populational variability within the widely dibributed *V. lasiostachys*, with which it is sympatric. As a hypothesis to encourage more detailed study, *V. abramsii* is tentatively accepted here, and its description is drawn from the specimens studied.

VERBENA ABRAMSII Moldenke, Amer. Midl. Nat. 24: 750. 1940. *Verbena lasiostachys* var. *abramsii* (Moldenke) Jeps., Fl. Calif. 3(2): 381. 1943. **TYPE: USA. California**. San Diego Co.: Hot Springs, southern part of San Diego Co., 1875, *E. Palmer 309* (holotype: NY! digital image!; isotypes: NY! digital image!, UC).

Perennial herbs, taprooted. **Stems** 3–8 from the base, prostrate to decumbent, often rooting at the nodes, ascending to erect-ascending distally, 15–55 m, moderately hirsute-villous to villous with flattened, non-glandular hairs uneven in orientation, sparsely stipitate-glandular with hairs much shorter than the non-glandular ones. **Leaves**: obovate to oblanceolate or oblong-obovate in outline, with or without a petiolar region, basal deciduous by flowering, lower cauline persistent, midstem blades 2–8 cm x 5–30 mm, margins coarsely serrate with 2–6(–8) teeth per side, rarely approaching 3-lobed if the proximal pair of teeth enlarged, slightly revolute if at all, both surfaces hirsute to hirsute-strigose, sparsely stipitate-glandular, veins not impressed adaxially. **Fruiting spikes** 1–6 from medial to distal branches, remaining somewhat compact with fruits slightly overlapping, 6–20 cm; rachis vestiture like the cauline or slightly more glandular; floral bracts ovate to ovate-acuminate, shorter to longer than the calyces, margins ciliate. **Calyces** 2–2.5 mm, hirsute and hirsutulous, densely short-stipitate-glandular, lobes shallowly deltate to deltate or deltate-apiculate, ca. 1/2 as long as the nutlets, erect to incurved. **Corollas** (tube and limbs) purple to blue, throat white, tubes 3–4 mm, 1–1.5 mm longer than the calyx, limb 2–3 mm in diam. **Nutlets** 1.1–1.4 mm, commissural faces extending completely to apices, minutely papillate.

Flowering May–Aug. Stream and lake edges, marshy meadows, seepage areas; 300–800 m; California.

Additional collections examined: **California. San Bernadino Co.**: San Bernadino Valley, damp land, meadows or swamps, ca. 300 m, 16 Jul 1907, *Parish 6295* (TEX). **San Diego Co.**: Lake Henshaw, SE of East Grade Road and E of Henshaw Truck Trail, ca. 1.3 air mi E of the dam, along the stream feeding into the NE portion of the Lake and on the NE shore, riparian vegetation with Salix, 9 Jul 2007, *Rebman 13625* (ARIZ). **Los Angeles Co.**: Claremont, spontaneous in Botanic Garden trickle, 25 May 1954, 1350 ft, *Balls 19393* (TEX); Liebre Mts., Knapp Ranch area at upper end of Castaic Creek drainage in broad alluvial valley at head of Cienaga Canyon, S. of Liebre Mt., near 34° 40' 49.7 N 118° 40' 03.3 W, springs area with overstory of *Baccharis salicifolia*, *Salix lasiolepis*, *S. laevigata*, *S. exigua*, understory of dense stands of *Carex*, *Anemopsis*, *Juncus*, water running on the surface in many areas, 3000 ft, perennial herb occasional in drier openings within meadow areas, 24 Sep 1996, *Boyd 8945* (NY); Upper Cienega Canyon, S base of Liebre Mountain, just on the N side of the "Kelly Ranch" inholding, ca. 3280-3340 ft, low marshy meadow fed by a drainage off the S face of the mountain, and apparently by subsurface seepages, 7 Jul 1994, *Ross 8151* (TEX). **Monterey Co.**: Abbott Lakes, Arroyo Seco Forest Service Campground, strand of lake below highwater line, stems prostrate, rooting, 6 Aug 1963, *Howell 40039* (LL)

ACKNOWLEDGEMENTS

Collections have been studied from NY, LL-TEX, BRIT-SMU and I am grateful to staffs at those herbaria for their hospitality. This research was done in conjunction with preparation of the FNA treatment of *Verbena* and supported in part by the Flora of North America Association.

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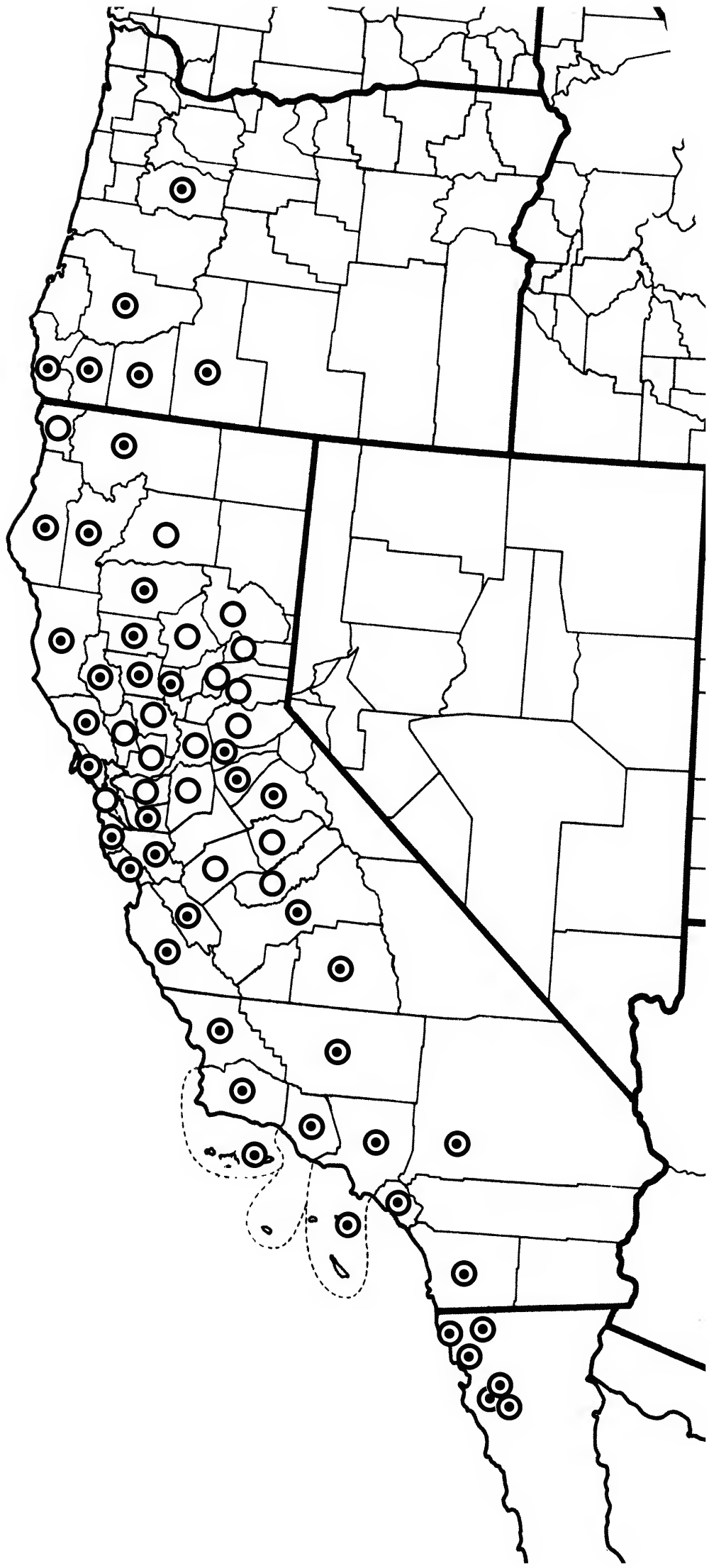

Figure 1. Distribution of *Verbena lasiostachys* in Baja California and by county in the USA based on specimens examined. Open symbols are added from records in Calflora (2010) and Moldenke (1964a and b).

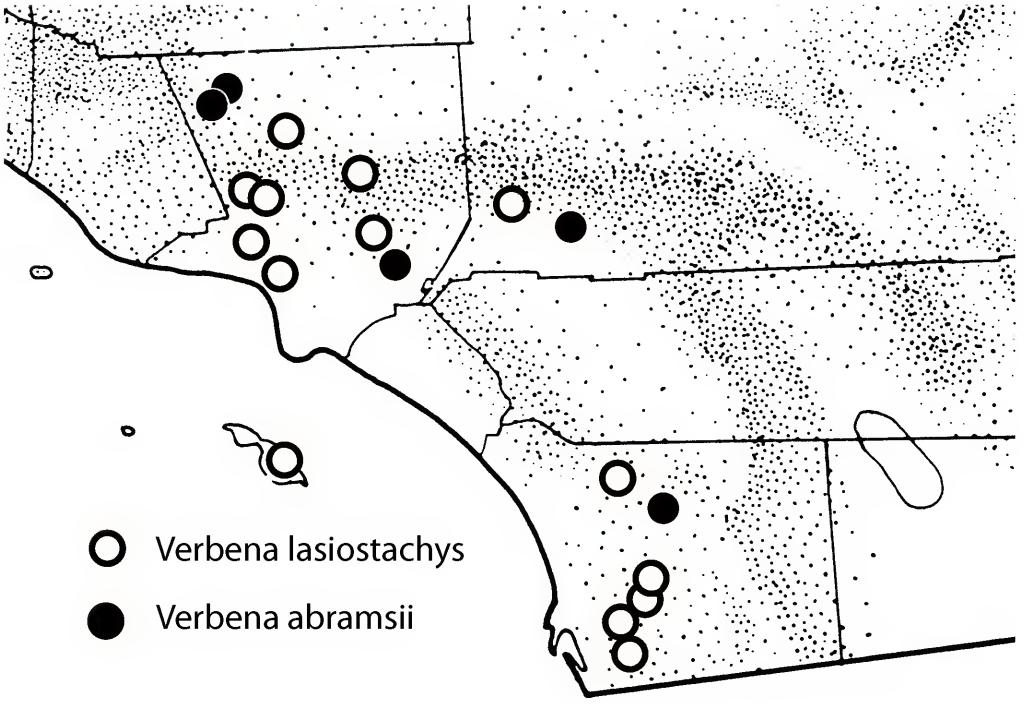

Figure 2. Detailed distribution of *Verbena lasiostachys* and *V. abramsii* in southern California, based on collections studied. According to Moldenke (1940, 1961), the range of *V. abramsii* extends further northward (see text).

Nesom, G.L. 2010. Validation of series names in *Verbena* (Verbenaceae). Phytoneuron 2010-27: 1–2. Mailed 16 July 2010.

VALIDATION OF SERIES NAMES IN *VERBENA* (VERBENACEAE)

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ABSTRACT

Ser. *Pacificae* Nesom and ser. *Austrobrasilienses* Nesom of *Verbena* sect. *Amphepetros* Nesom, a primarily South American group, are validated by including morphological components in the Latin diagnoses. *Verbena* sect. *Verbena* ser. *Haleanae* is validated as the name of the series including *V. halei*.

In an infrageneric classification of *Verbena* (Nesom 2010), two names at the rank of series were published with Latin diagnoses including only a geographic component. As pointed out to me by Katherine Challis (IPNI Editor, Kew), these names were invalidly published since the International Code of Botanical Nomenclature (McNeil et al. 2006; Article 32.3) notes that requirements for the diagnosis or description of a protologue are not met by statements describing properties of geographic origin. The names are properly validated here.

Verbena series **Pacificae Nesom, ser. nov. TYPE**: *Verbena glabrata* Kunth

Distributione geographica plerumque secus Oceanum Pacificum distinctus. A ser. *Austrobrasilienses* characteribus variabilis caulium foliorum, inflorescentiae, florum, ac fructuum differt; proprietatibus nondum studens differe praedicans.

Verbena series **Austrobrasilienses Nesom, ser. nov. TYPE**: *Verbena hirta* Sprengel

Distibutione geographica plerumque in Brasilia australi distinctus. A ser. *Pacificae* characteribus variabilis caulium foliorum inflorescentiae florum ac fructuum differt; proprietatibus nondum studens differe praedicantibus.

The two diagnoses in the earlier paper were based on geography because of a wide and prominent disjunction between the two species groups — ser. *Pacificae* from Pacific Ocean regions of South America to Mexico and ser. *Austrobrasilienses* from a center in the southernmost states of Brazil. As observed in the original publication (Nesom 2010, p. 11), "The separation of ser. *Austrobrasilienses* and ser. *Pacificae*, based on geography, hypothesizes that other distinctions remain to be discovered; a clear morphological difference is not apparent, but the geographically-based names provide reference to the groups. It also is acknowledged that the separation may be arbitrary."

The *Verbena* classification, like any other, is a hypothesis that involves elements of description and predictivity. Geography is perhaps the strongest predictor in systematics and, in this case, suggests that further study may bring to light morphological or molecular differences correlated with the geographical separation. Exclusion of geographical difference as a valid basis for formal recognition of taxa above species rank may have moved the ICBN further than justified into subjectivities of biological and evolutionary theory.

Dr. Challis also has noted that publication of *Verbena* ser. *Haleae* Nesom (Nesom 2010, p. 8) was invalid, "because the epithet appears to be a feminine noun in the genitive singular which is not allowed under [ICBN] Art. 21.2. I assume this was an attempt to form a plural adjective from the

epithet of the type species, but that (halei) is a masculine genitive noun which would become haleorum in the plural. The feminine adjectival form of the epithet would be haleana (pl. haleanae)." The correction is made here.

Verbena series **Haleanae Nesom, ser. nov.** TYPE: *Verbena halei* Small

Foliis crassibus venis adaxialiter impressis marginibus revolutis caulium lobatis et spicis numerosibus fructibus late remotis ad maturitatem distinctus.

ACKNOWLEDGEMENTS

I'm grateful to Katherine Challis and Kanchi Gandhi for comments.

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Nesom, G.L. 2010. A new species of *Erigeron* (Asteraceae: Astereae) from northwestern Chihuahua, Mexico. Phytoneuron 2010-28: 1-6. Mailed 16 July.

A NEW SPECIES OF *ERIGERON* (ASTERACEAE: ASTEREAE) FROM NORTHWESTERN CHIHUAHUA, MEXICO

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ABSTRACT

Erigeron nitens Nesom, sp. nov., is described from northwestern Chihuahua, Mexico, where it apparently is narrowly endemic. It is most similar and probably closely related to *E. arizonicus*, differing in its glabrous stems, leaves, and phyllaries and in its serrate, pinnately nerved, and non-clasping leaves.

KEY WORDS: *Erigeron*, Astereae, Asteraceae, new species, Chihuahua

Exploration in northwestern Chihuahua by students from Northern Arizona University has brought to light an undescribed species of *Erigeron*, represented by two collections. The species is highly distinctive, suggesting that mountains of this area have not previously been botanically explored.

Erigeron nitens Nesom, sp. nov., Figs. 1, 2, 3, 4, and 5

Erigeronti arizonico A. Gray similis sed praesertim differt caulibus foliis ac phyllariis paene penitus glabris et foliis serratis pinnatinervibus non amplexicaulibus.

TYPE: **Mexico**. **Chihuahua**. Sierra Madre Occidental, Rincon de las Tinajas, 30° 33' 26" N, 108° 38' 40" W, ca. 2388 m, mixed conifer-oak (*Pinus*, *Pseudotsuga*, *Quercus*) with *Lupinus*, *Lopezia*, *Oxalis*, *Brickellia*, *Galium*, *Silene*, *Pyrola*, 13 Sep 2009, *M. Joe 294* with C. Cortes (holotype: TEX; isotype: ASC, others to be distributed).

Perennial herbs, rhizomatous, fibrous-rooted, rhizomes relatively thick, mostly simple. **Stems** erect-ascending at the base, 30–35 cm high, completely glabrous or sparsely hirsutulous only immediately below the heads. **Leaves** basal (persistent) and cauline, basal and proximal largest or sometimes enlarging immediately above the basal, spatulate-petiolate, pinnate-nerved, completely glabrous except for sparsely ciliate margins, blades obovate to elliptic-ovate, 1.5–6 long, 1–2.5 cm wide, basally attenuate to a petiolar region 1.5–8 cm long, margins shallowly serrate to sinuate-serrate with 3–5(–7) pairs of teeth, cauline becoming obovate and epetiolate then lanceolate near the heads, sharply to shallowly serrate. **Heads** [probably 1–]3 from branches on distal 1/3–1/4 of stem, bracteate peduncles 4–10 cm. **Involucres** 4–5 high, 9–12 mm wide; phyllaries in 2–4 series, greenish-brown, with 3 parallel veins (golden-brown because of oil ducts), glabrous (no hairs or glands), linear-lanceolate, apices abruptly acute. **Ray florets** 30–50, corollas white, drying lilac-tinged, 10–11 mm long, ca. 1 mm wide, lamina weakly coiling at the tips. **Disc florets** 2.5–3 mm long. **Achenes** 1.8 mm long, with 2 thick, golden-brown lateral nerves, often with a third nerve closely associated with one of the laterals, faces sparsely strigose; pappus bristles 18–20, ca. 2 mm long, with a few short outer setae.

Flowering Aug–Oct. Mixed conifer and oak woods; 2300–2500 m elevation. The epithet (Latin, *nitens*, shining, smooth) alludes to the glabrous stems and leaf surfaces.

Additional collection examined: **Mexico**. **Chihuahua**. Sierra Madre Occidental, Mesa Prieta Sur, 30° 29' 12" N, 108° 32' 28" W, 2424 m, [mixed conifer] (*Cupressus*, *Pinus*, *Pseudotsuga*) with *Aquilegia*, *Bromus*, *Thalictrum*, *Artemisia*, *Oxalis*, *Brickellia*, *Robinia*, *Galium*, 10 Sep 2009, *M. Joe 257* with C. Cortes (ASC, TEX).

The collections of *Erigeron nitens* were made in the Mesa de las Guacamayas, a remote mountainous area about 70 kilometers west-northwest of Nuevo Casas Grandes, immediately along the border of Sonora and just west of Rio San Pedro. The Mesa de las Guacamayas is found within the Ejido 5 de Mayo, a collectively held land unit that encompasses more than 25,000 hectares in the mountains and piedmont of the Sierra Madre Occidental. The highest point of the range is Cerro El Palomo, a peak of nearly 2700 meters according to Google Earth. The type locality is 1.5 miles west of the peak and about 0.5 miles east of the Sonoran border. The paratype was collected about 7.5 miles southeast of the type. The area of high elevation is continuous into immediately adjacent Sonora, and *E. nitens* almost certainly occurs as well in that state.

"The type and paratype localities are part of a permanent plot grid set up to study the fire regimes and ecological dynamics of old growth forests in the northwest of México. The names of the sites (Rincón de las Tinajas and Mesa Prieta Sur) do not necessarily represent local toponymies. Forests at both sites had an understory dominated by large and old (>300 years old) trees (>50 cm DBH) of *Pinus* and *Pseudotsuga*" (fide C. Cortes, pers. comm.).

Erigeron nitens is a member of sect. *Fruticosus* G. Don (Nesom 1982, 2008). A number of these species occur in southern New Mexico and Arizona—*E. arizonicus* A. Gray, *E. coulteri* Porter, *E. hessii* Nesom, *E. kuschei* Eastw., *E. rybius* Nesom, *E. speciosus* (Lindl.) DC., and *E. vreelandii* Greene (Nesom 2006). Of these *E. arizonicus*, *E. speciosus*, and *E. vreelandii* extend into northern Mexico, but *E. nitens* is the only one of the group endemic to Mexico.

Among the species of sect. *Fruticosus*, *Erigeron nitens* is most similar to *E. arizonicus*, which is localized in southern Arizona and southwestern New Mexico, touching into Sonora in the San Jose Mountains, essentially a southward extension of the Huachuca Mountains (Fig. 1). The two species are similar in their spatulate basal and lower cauline leaves, relatively short stems arising from short, fibrous-rooted rhizomes, and few heads with white, weakly coiling rays.

Among the most conspicuous differences between the two species is the nearly complete lack of vestiture on the stems, leaves, and phyllaries of *Erigeron nitens*—except for the ciliate leaf margins and the sparsely hirsutulous zone immediately below the heads, there are neither glands nor non-glandular hairs. *Erigeron arizonicus* is variable in vestiture, but all plants have hirsute to hirsute-strigose leaf surfaces, the stems characteristically are strigose or hirsute-strigose, and the phyllaries are consistently minutely stipitate-glandular. The entire leaf margins of *E. arizonicus* are completely consistent, emphasizing the serrate leaves of the new species as distinct. Differences are summarized here.

1. Stems, leaf surfaces, and phyllaries glabrous; cauline leaves not at all clasping; leaves pinnately nerved; cauline leaves not at all clasping; phyllary apices relatively thick and abruptly acute to obtuse ..... **Erigeron nitens**

1. Stems and leaf surfaces glabrate to strigose, hirsute, or villous, phyllaries minutely stipitate-glandular with non-glandular hairs variably present; basal and at least the proximal cauline leaves distinctly 3-nerved; cauline leaves usually subclasping; phyllary apices relatively thin and drawn out into loose appendagelike extensions ..... **Erigeron arizonicus**

ACKNOWLEDGEMENTS

I'm grateful to Amber Schoneman (TEX) for her alacritous preparation of the high-res photos of the two specimens, the staff at TEX-LL for their hospitality, Tina Ayers (ASC) helpful comments, and to Citlali Cortes Montano, ASC student in forestry, for comments on the collection localities and biology The collector, Marissa Laurel Joe, is an ASC student in botany

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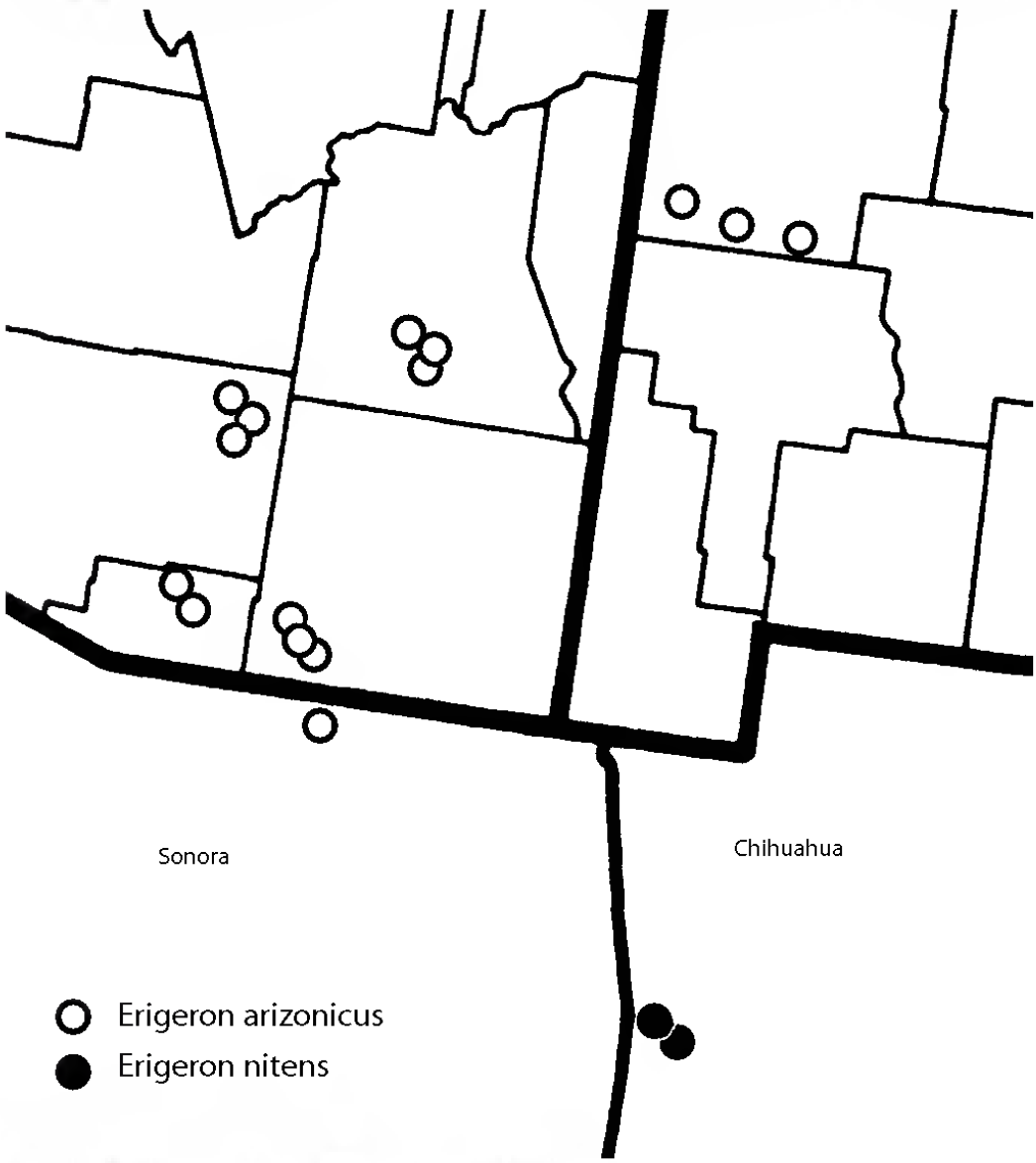

Fig. 1. Distribution of *Erigeron nitens* and *E. arizonicus*

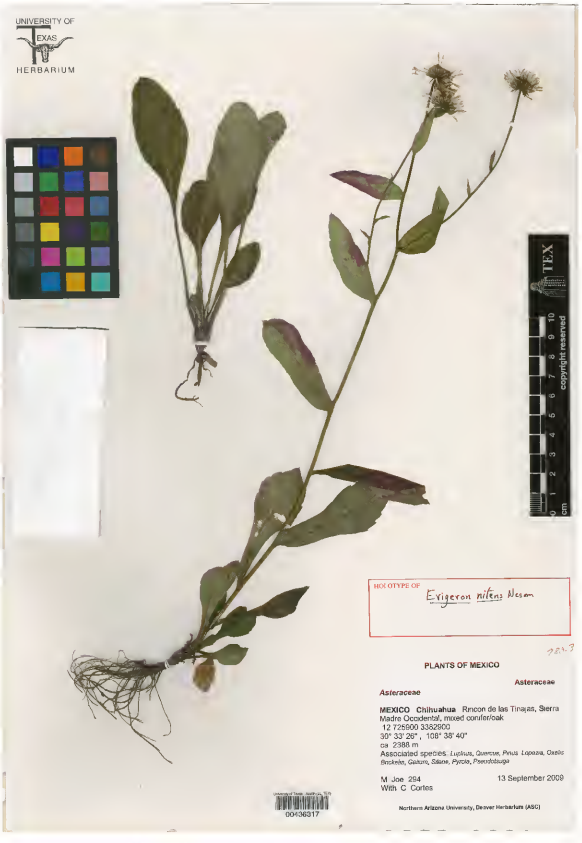

Fig. 2. Holotype of *Erigeron nitens* (*M. Joe 294* with C. Cortes).

Fig. 3. Paratype of *Erigeron nitens* (*M. Joe 257* with C. Cortes).

Fig. 4. Head of holotype.

Fig. 5. Leaf and stem of holotype.

MacRoberts, M.H. and B.R. MacRoberts. 2010. *Hydrocleys nymphoides* (Limnocharitaceae): New to Louisiana. Phytoneuron 2010-29: 1–2.

HYDROCLEYS NYMPHOIDES (LIMNOCHARITACEAE): NEW TO LOUISIANA

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ABSTRACT

Hydrocleys nymphoides (Willd.) Buchenau is documented as growing outside of cultivation in Caddo Parish, Louisiana, the first record for the state.

KEY WORDS: Limnocharitaceae, *Hydrocleys nymphoides*, Louisiana, non-native species.

On 8 July 2010, we discovered *Hydrocleys nymphoides* (Willd.) Buchenau, commonly known as water-poppy, growing in a ditch in Columbia Park, a four hectare public park in Shreveport, Louisiana (Caddo Parish). Specimens were collected (*MacRoberts & MacRoberts 8660, 8669, 8670*) and deposited at LSU and LSUS).

The *Hydrocleys* population covers a one-by-three meter area at ca. 70 m elevation (32° 28' 59.9" N, 93° 44' 41.5" W). It produced 18 flowers (Figs. 1 and 2) during the period 8–25 July. The ditch is wet with slow-flowing water and standing shallow pools and is partly fed by seepage from surrounding hills. Associated species included *Acmella repens*, *Alternathera philoxeroides*, *Cyperus flavicomus*, *Diodia virginiana*, *Eleocharis obtusa*, *Hydrocotyle verticillata*, *Kyllinga brevifolia*, and *Sagittaria platyphylla*.

Hydrocleys nymphoides, a native of Central and South America, has previously been reported from Florida and southeastern Texas but not Louisiana (Haynes 2000; Turner et al. 2003; Kartesz & Meacham 2005; Diggs et al. 2006; NatureServe 2010; USDA, NRCS 2010). *Hydrocleys* is sometimes grown as an aquarium plant or cultivated in pools and ponds and persists following dumping of aquaria (Diggs et al. 2006). How long the species has been in Columbia Park is not known, but a dog walker and horticulturist told us that it was not there in 2009.

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Figure 1. *Hydrocleys nymphoides* in Columbia Park, Shreveport, La.

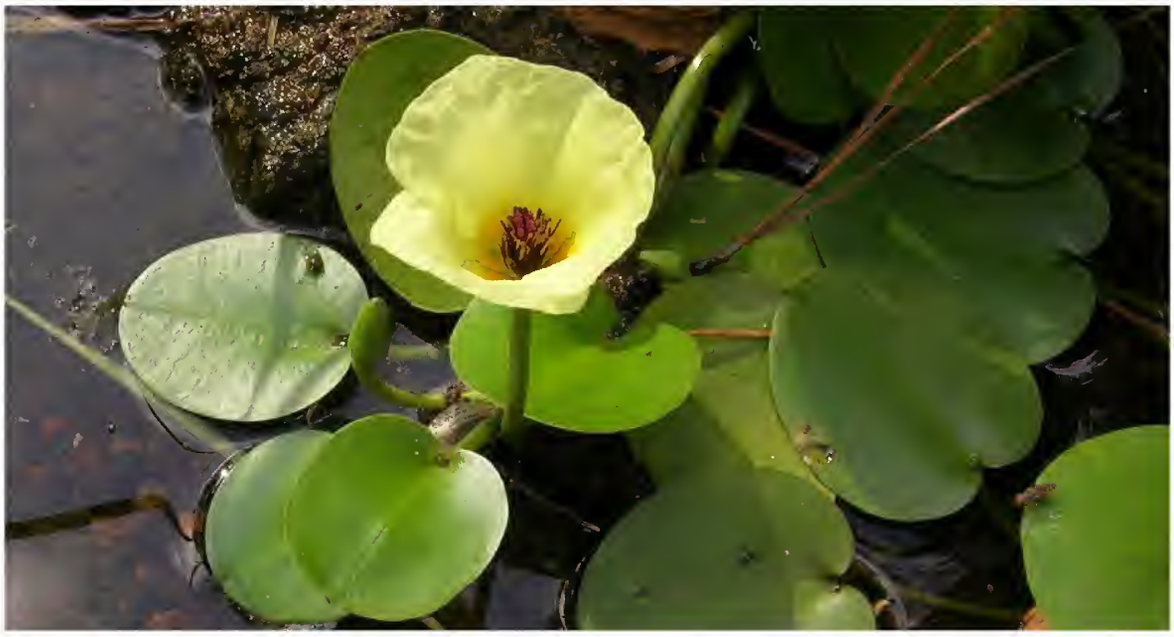

Figure 2. *Hydrocleys nymphoides* flower.

PERSICARIA PERFOLIATA (POLYGONACEAE) REACHES NORTH CAROLINA

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ABSTRACT

Persicaria perfoliata is documented as established for the first time in North Carolina. This taxon is a state-listed Class A noxious weed that has very aggressive naturalizing tendencies. At least three distinct populations have been discovered in north central Alleghany County. Plants in all localities are fruiting rampantly and spreading to adjacent disturbed areas. A key is provided to help differentiate similar congeners in North America and color photos show features of the habitats and plants.

KEY WORDS: *Persicaria perfoliata*, *Polygonum*, Polygonaceae, Mile-a-minute, North Carolina

Persicaria perfoliata (L.) H. Gross. Mile-a-minute-vine, Asiatic Tearthumb

North Carolina. Alleghany Co.: Piney Creek Township, Amelia. Located off of Elk Creek Church Rd. (SR 1344), ca. 0.3 km from the Virginia State Line and ca. 2.9 km north of Amelia at 36°34'10.6"N, 81°12'23.8"W, elev. 826 m. Growing in a roadside drainage area, along Elk Creek,. Infrequent (30+ individuals); 3 Sep 2008, *D.B. Poindexter 08-1149* (BOON, NCU).

Piney Creek Township, Amelia. Located along Reeves Ridge Rd. (SR 1346), ca. 1.7 km sw of the NC 93 jct. at 36°31'57.4"N, 81°12'41.8"W, elev. 800 m. Growing in disturbed areas along the road/fence line adjacent to a mowed pasture. Occasional (50-100 individuals); 19 Jul 2010, *D.B. Poindexter 10-417* (BOON).

Prathers Creek Township, Stratford. Located along US Hwy 221, ca. 5.5 km east of the NC Hwy 113 jct. at 36°30'09.2"N, 81°14'16.0"W, elev. 827 m. Growing on a highly disturbed embankment on the northwest side of the road. Abundant (1000+ individuals); 9 Jul 2010, *D.B. Poindexter 10-409* (BEREA, BOON, NCU).

Mile-a-minute-vine is a member of *Persicaria* sect. *Echinocaulon* (Hinds and Freeman 2005). It is native to a broad area of eastern Asia, and exhibits an annual growth duration, a vinaceous habit, and a broad ecological tolerance. Despite its adaptive ability, this invasive species has a preference for sun-exposed, disturbed mesic sites and is not very tolerant of excessive heavy shade (Oliver 1996). Common habitats include roadsides, pastures, cleared forests, croplands, nurseries, and natural areas such as bottomland riparian corridors (Oliver 1996). This plant has become a problematic agrestal weed in east Asia but has shown only a limited such tendency in North America, perhaps due to our more intensive agricultural practices (Kumar & DiTommaso 2005).

As with most annuals, its reproductive success is inferred to be dependent upon mass fruit production, in concurrence with high rates of seedling recruitment (Oliver 1996). This biological strategy is likely responsible for its ease of colonization and subsequent range expansion. Natural animal vectors include birds and rodents, but anthropogenic dispersal is the most pragmatic explanation for its rapid spread. Contaminated nursery stock and hydrochory (dispersal of the buoyant fruits by water) have been traced as the initial culprits for dispersal in the eastern United States (Cusick & Ortt 1987). Mile-a-minute-vine's propensity to outcompete native vegetation and

cultivated crops makes it a formidable early successional invasive of major concern to both agriculturalists and conservation agencies over its range of naturalization. The plant's dense retrorse prickles, along with its rapid growth rate (hence the name Mile-a-minute-vine) of up to 15 cm per day (Kumar & DiTommaso 2005), allow *Persicaria perfoliata* to overtop surrounding vegetation and climb into neighboring forest subcanopies (Figs. 1–2). It is for this reason that Mile-a-minute-vine has been considered a severe threat to forest regeneration (Wu et al. 2002).

Taxonomy.

Mile-a-minute-vine shares some morphological semblance to its other scandent, native eastern North America counterparts, *Persicaria arifolia* (L.) Harolds. (Halberd-leaf Tearthumb), *P. meisneriana* (Cham. & Schltdl.) Meisn. var. *beyrichiana* (Cham. & Schltdl.) C.C. Freeman (Mexican Tearthumb), and *P. sagittata* (L.) Gross. (Arrowleaf Tearthumb) (Figs. 3–6).

Like these native species, *Persicaria perfoliata* has retrorse prickles on the stems and abaxial leaf midveins. In contrast, these four taxa are markedly different from each other with respect to leaf shape, the sheathing connate stipules (ocreae), and flower and fruit morphology. The following key is provided to help differentiate these entities and is adapted from Hinds and Freeman (2005) and Weakley (2010). The only other member of sect. *Echinocaulon* known from North America north of Mexico, *P. bungeana* (Turcz.) Nakai ex T. Mori (Prickly Smartweed), is excluded. This taxon is an exotic introduction in soybean fields, known from Iowa, Illinois, and Minnesota. It differs primarily from the climbing species of this section in its ascending to erect habit and truncate ocreae margins with cilia to 4 mm (Hinds & Freeman 2005).

1. Ocreae foliaceous, perfoliate and flared around the nodes; leaves petiolate, peltate, deltoid, bases truncate to cordate; tepals 5, fleshy and bright blue in fruit; mature achenes spheroidal [exotic] ..... ***P. perfoliata***
1. Ocreae chartaceous, cylindric and encircling the stem; leaves not peltate, varying in shape (but not promintently deltoid); tepals 4–5, not fleshy or blue in fruit; mature achenes not spheroidal [native].

2. Mid-stem leaves mostly sessile (rarely short petiolate), linear-lanceolate, usually cuneate (rarely rounded to cordate) at the base; inflorescence branches stipitate-glandular; tepals 5; mature achenes trigonous ..... ***P. meisneriana* var. *beyrichiana***
2. Mid-stem leaves petiolate, sagittate-auriculate or hastate.

3. Leaves hastate, basal lobes spreading; inflorescence branches stellate pubescent and stipitate-glandular; tepals 4; mature achenes biconvex ..... ***P. arifolia***
3. Leaves sagittate-auriculate, basal lobes often extending around the stem where petioles are short; inflorescence branches glabrous; tepals 5; mature achene trigonous ..... ***P. sagittata***

To address the nomenclatural history of this taxon, a brief synopsis of the synonomy of Mile-a-minute-vine is given below derived from MBG (2010).

Persicaria perfoliata (L.) H. Gross, Beih. Bot. Centralbl. 37. II. 113. 1919
Ampelygonum perfoliatum (L.) Roberty & Vautier, Boissiera 10: 31. 1964.
Chylocalyx perfoliatus (L.) Hassk. ex Miq., Flora 25(2): 20. 1842.
Echinocaulon perfoliatum (L.) Meisn. ex Hassk., Flora 25(2): 20. 1842.
Fagopyrum perfoliatum (L.) Raf., Fl. Tellur. 3: 10. 1836 [1837].
Polygonum arifolium L. var. *perfoliatum* L., Systema Naturae, Editio Decima 2: 1006. 1759.
Polygonum perfoliatum (L.) L., Systema Naturae, Editio Decima 2: 1006. 1759.
Tracaulon perfoliatum (L.) Greene, Leafl. Bot. Observ. Crit. 1: 22. 1904.
Truellum perfoliatum (L.) Soják, Preslia 46(2): 148. 1974.

History and Distribution.

Persicaria perfoliata first appeared in North America around 1890, based on an herbarium specimen collected from ballast in Oregon. A second western North American collection was reported from British Columbia in 1954. Neither of the two populations were documented as established and both are presumed to have been based on ephemeral adventives (Cusick & Ortt 1987; Oliver 1996; Wu et al. 2002). Likewise, the colder climates of the Pacific Northwest were likely non-conducive to the naturalization of this taxon. The first records for eastern North America were from Maryland and Pennsylvania in the late 1930's. One of the oldest specimens was documented from a York County, Pennsylvania orchard in 1946, but it and others likely originated from contaminated nursery stock (Oliver 1996; Wu et al. 2002). Mile-a-minute-vine has subsequently spread from this point of origin to surrounding states.

Mile-a-minute-vine is currently known from Connecticut, Delaware, the District of Columbia, Maryland, Massachusetts, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Virginia, and West Virginia (Hinds & Freeman 2005; Hough-Goldstein et al. 2008; Kartesz 2010; USDA, NRCS 2010; Weakley 2010). Hinds and Freeman (2005) listed an additional record from Mississippi; however, this is likely an error based on a misunderstanding of a paper by Cusick and Ortt (1987), which described a new locality of Mile-a-minute-vine in West Virginia, within the Mississippi Drainage. Its center of distribution is the Mid-Atlantic States, with only a few aforementioned adventive outliers (Fig. 7). However, this species has become a noxious weed in these Atlantic states and is rapidly expanding its range southward. Oliver's (1996) prognostication that "The southward direction of spread suggests that this plant will probably proliferate in a number of southern states, unless it is actively controlled." This expansion in geographical range seems to have been an accurate prediction in light of the recent discovery reported here for North Carolina.

The only previous detection of *Persicaria perfoliata* in North Carolina was on June 12, 2000, in Wake County, where two plants were found growing in pots containing Hostas (*Hosta* sp.) inside a contained greenhouse (NCDA & CS 2010a). Prior to the population found in Alleghany County, *P. perfoliata* had not yet been documented as naturalized in the state. It was found in three separate populations, with the largest engulfing a disturbed roadside embankment (Fig. 1).

This report represents the southernmost distribution record in the United States. It is impractical to target the exact mode of transportation that allowed this plant to enter North Carolina. However, it could be speculated that the large import of hay from various northern states during the 2007 drought year may have been responsible for its introduction (Rick Iverson, pers. comm. 2010).

The North Carolina Department of Agriculture considers this taxon to be a Class A noxious weed (NCDA & CS 2010b), a category reserved primarily for plants that are federally-listed species, which have or show potential for broad ecological and agricultural/economic impact. The likelihood for future range extension of this taxon is great, as indicated by its history of expansion and close affiliation with cultivation and other anthropogenic activities.

Prompt management practices are imperative to impede the further spread of this taxon. Plans to eradicate these newly discovered populations are underway by the North Carolina Department of Agriculture and Consumer Services, Plant Industry Division (Rick Iverson, pers. comm. 2010). The most obvious control methods rely on mechanical removal. However, biological control studies utilizing the Asian weevil *Rhinoncommus latipes* Korotyaev have demonstrated a negative impact on the growth and reproduction of *Persicaria perfoliata*, thus reducing its competitive capacity (Hough-Goldstein et al. 2008). Ultimately, success will be dependent upon annual monitoring, but if the Mid-Atlantic States are a true testament of this plant's ability to proliferate, complete eradication may be a futile effort.

ACKNOWLEDGEMENTS

I would like to thank the Roaring Gap Donors for graciously providing funding for a long-term study of the vascular flora of Alleghany County, NC. This grant has engendered a wealth of botanical discovery, of which this paper is a reflection of their financial contributions. I am also grateful to Dr. Guy Nesom, Dr. Ralph Thompson (BEREA), and Dr. Alan Weakley (NCU) for suggestions and critical reviews of this manuscript.

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Figure 1. Disturbed habitat and adjacent woodland ecotone enveloped by *Persicaria perfoliata*

Figure 2. *Persicaria perfoliata* climbing over vegetation and into surrounding canopy trees (e.g., *Robinia pseudoacacia* L.).

Figure 3. (A) Bright blue, 5-parted mature tepals of *Persicaria perfoliata,* (B) developing fruits, and (C) partially exposed, mature spheroidal achenes.

Figure 4. Infructescence and deltoid stem leaves of *Persicaria perfoliata*. Note the leafy ocreae subtending the fruit and at the nodes of the stem.

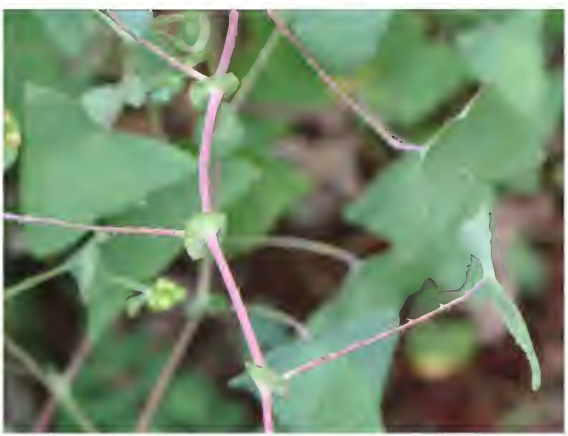

Figure 5. Stem and petioles of *Persicaria perfoliata* exhibiting retrose prickles. Note that the petiole attachment is peltate (on the abaxial leaf surface) and not at the margin of the leaf.

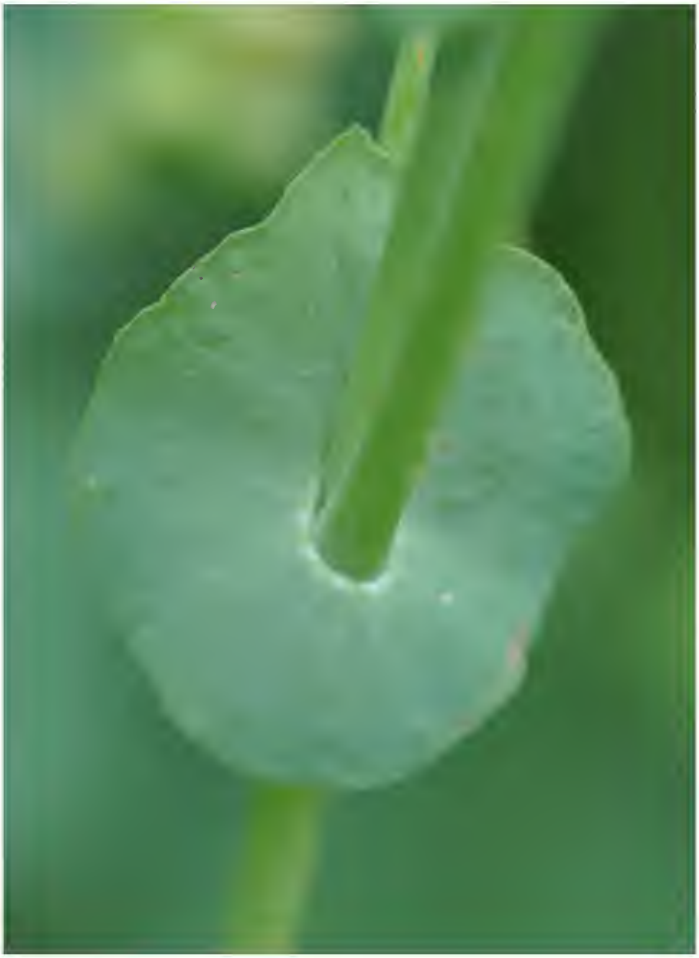

Figure 6. Close-up of a perfoliate ocrea.

Figure 7 Current distribution of *Persicaria perfoliata* in North America north of Mexico Non established states and provinces (black), and established states, including the District of Columbia, (gray) Areas of greatest concentration (dark gray)

Turner, B.L. 2010. Taxonomy of the *Penstemon campanulatus* complex (Scrophulariaceae) and description of a new species from its midst. Phytoneuron 2010-31: 1–5. Mailed 10 August 2010.

TAXONOMY OF THE *PENSTEMON CAMPANULATUS* COMPLEX (SCROPHULARIACEAE) AND DESCRIPTION OF A NEW SPECIES FROM ITS MIDST

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ABSTRACT

The taxonomy of the wholly Mexican species *Penstemon campanulatus* is reviewed, resulting in the description of a new taxon, **P. wendtiorum** B.L. Turner, **sp. nov.**, and the change of *P campanulatus* subsp. *chihuahuensis* to varietal rank (as var. **chihuahuensis** (Straw) B.L. Turner, **stat. nov.**).

KEY WORDS: *Penstemon, P. campanulatus,* Scrophulariaceae, Mexico, Coahuila

Straw (1963) provided an excellent treatment of the *Penstemon campanulatus* complex, viewing it as divided into three subspecies. The following key is adapted from his study:

1. Mid-stems variously eglandular-pilose with light brown to white hairs mostly ca 1 mm long; north-central Mexico (Chihuahua, Durango) ..... subsp. **chihuahuensis**
1. Mid-stems glabrous to minutely puberulent, any longer hairs glandular.

2. Branches of inflorescence glandular-pubescent ..... subsp. **campanulatus**
2. Branches of inflorescence not as above, glandular hairs confined to calyces and pedicels; localized endemic (Sonora) ..... subsp. **subglandulosus**

Subsp. **campanulatus**

This, the typical subspecies, is based upon a collection from south-central Mexico. It is best recognized by its narrowly lanceolate leaves and glandular-pubescent upper stems and leaves, the lower stems to some degree glabrous or minutely pubescent. It intergrades with subsp. *chihuahuensis* in Durango where their distributions overlap (along highway 40 between the city of Durango and El Salto).

Subsp. **chihuahuensis** Straw

This taxon is typified by material collected by *Townsend & Barber 106*, from near Colonia Garcia, Chihuahua, Mexico. It is a very distinct taxon, what with its characteristic pubescence, as noted in the above key. Did it not intergrade into the typical subspecies in the vicinity of Cd. Durango, it would probably be worthy of specific rank.

Subsp. **subglandulosus** (S.S. White) Straw

This is a weakly differentiated, very localized taxon typified by a collection from Huepari Cañon in central Sonora. Straw (1963) stated that when first assessed, he "thought this taxon should be raised to specific rank." But further studies showed "that this local population intergrades both in pubescence and in leaf characters with other populations, as in collections of Hewitt from nearby Chihuahua. On this account the taxon is left in a subspecific status. It does, apparently, have a certain geographic standing which is interpreted, along with the morphology, to warrant more than the varietal position originally given to it." Unfortunately, Straw did not define his varietal or subspecific concepts, but I conclude from his comments quoted here that any recognizable

populational unit should be given subspecific status and that the term variety is to be used for non-biological taxonomic units.

Regardless, I view the above named taxa as only varietally distinct since they intergrade with each other in or near regions of contact (cf. Turner and Nesom 2000, re my infraspecific concepts) and modify the nomenclature accordingly, as follows:

PENSTEMON CAMPANULATUS (Cav.) Willd., Sp. Pl. 3: 228. 1800.
Chelone campanulata Cav., Ic. 1: 18. t. 29. 1791.

Subsp. campanulatus

Var. campanulatus Map 1
The typical subspecies, by my calculations, contains but a single, highly variable, widespread variety that intergrades to a limited extent with var. *chihuahuensis* in central Durango, Mexico.

Subsp. chihuahuensis Straw, Brittonia 15: 59. 1963.
The subsp. *chihuahuensis* contains two intergrading varieties, as follows:

Var. chihuahuensis (Straw) B.L. Turner, **comb. et stat. nov. Map 2**
Penstemon campanulatus subsp. *chihuahuensis* Straw, Brittonia 15: 59. 1963.
As noted above, this taxon is best treated at the varietal level, hence the new combination proposed here.

Var. subglandulosus S.S. White, J. Arnold Arb. 28: 440. 1947. **Map 2**
Penstemon campanulatus subsp. *subglandulosus* (S.S. White) Straw, Brittonia 15: 58. 1963.
Straw (1963) elevated this weakly differentiated taxon to subspecific rank, as noted above. I think it most logically retained at the varietal level within the subsp. *chihuahuensis*, with which it intergrades.

In the course of the taxonomic venture discussed above, I chanced upon a specific novelty that clearly relates to the *Penstemon campanulatus* complex, this described below:

PENSTEMON WENDTIORUM B.L. Turner, **sp. nov. Fig. 1, Map 1** **TYPE: MEXICO. Coahuila. Mpio. Melchor Muzquiz:** Rincón de María, on Hacienda La Babia, which is ca. 70 mi by road NW of Muzquiz, around "Slump Spring" along the spring-level road in SW part of the rincón, wooded NE-facing sheltered slopes with openings around the spring, limestone area, 28° 28' N, 102° 04' 30" W, 1400 m, 26 Apr 1975, *Tom Wendt & David Rtskind 873* (holotype: TEX).

Penstemo campanulato (Cav.) Willd. similis sed differt foliis late lanceolatis (1.5–3.0 cm latis vs 0.5–1.5 cm), calycibus minoribus (6–7 mm longis vs 6–15 mm), et corollis minoribus (ca 2 cm longis vs 2.5–3.5 cm).

Suffruticose perennial herbs to 75 cm high. **Mid-stems** purplish, minutely and uniformly ciliate. **Leaves** broadly lanceolate, 5–7 cm long, 1.5–3.0 cm wide, essentially glabrous, except for minute ciliate hairs along the mid-ribs, the surfaces glandular-punctate, the margins serrate throughout, or nearly so; petioles 0–1 mm long. **Inflorescence** ca 20 cm long, bracteate, the larger bracts subcordate, 4 cm wide, having well-developed axillary branching, densely glandular-pubescent throughout, but not extending to adjacent lower stems. **Pedicels** 6–10 mm long. **Flowering calyces** 6-7 mm long. **Corollas** ca 2 cm long, 1 cm wide, "rose-lavender," glandular-pubescent, the lower lip pilose within, abruptly ampliate, the tube ca 4 mm long. **Capsule** (immature) ovate, ca 7 mm long, 4 mm wide, glabrous or nearly so.

Penstemon wendtiorum is distinct from *P. campanulatus* in its broadly lanceolate leaves (1.5–3.0 cm wide vs. 0.5–1.5 cm) and smaller flowers (calyces 6–7 mm long vs. 6–15 mm, corollas ca 2 cm long vs. 2.5–3.5 cm). Additionally, *P. campanulatus* is nearly always found at elevations between 2000 and 3000 meters, while the present novelty reportedly occurs at 1400 meters. The type locality of *P. wendtiorum* is known to harbor a number of yet other novelties, noteworthy being that of *Oenothera riskindii* W.L. Wagner (Syst. Bot. 30: 349. 2005).

It is a pleasure to name the taxon for one of its principal collectors, Dr. Tom Wendt, Curator LL-TEX, and his lovely wife Kathleen Collins, happily married for many years now.

ACKNOWLEDGEMENTS

I am grateful to Guy Nesom for the Latin diagnosis and to him and Tom Wendt for helpful suggestions. Distribution maps are based upon specimens on file at LL-TEX and specimens cited by Straw (1963).

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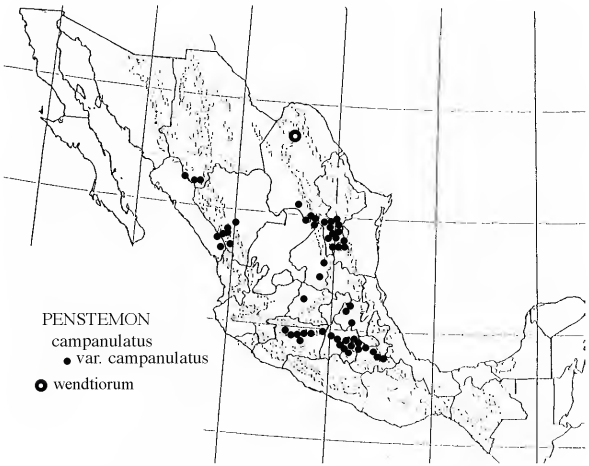
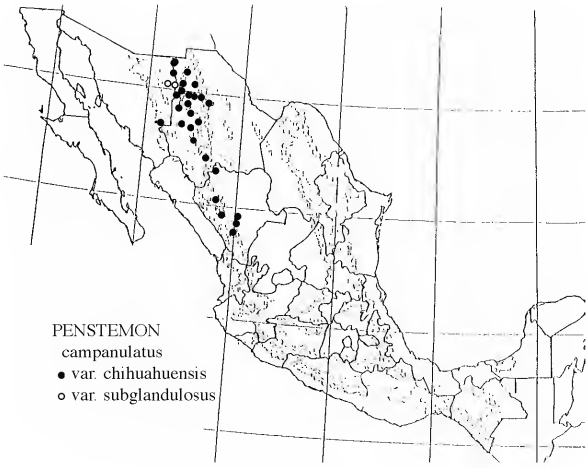


Map 1. Distribution of *Penstemon campanulatus* var. *campanulatus* and *P. wendtiorum*.



Map 2. Distribution of *Penstemon campanulatus* var. *chihuahuensis* and var. *subglandulosus*.

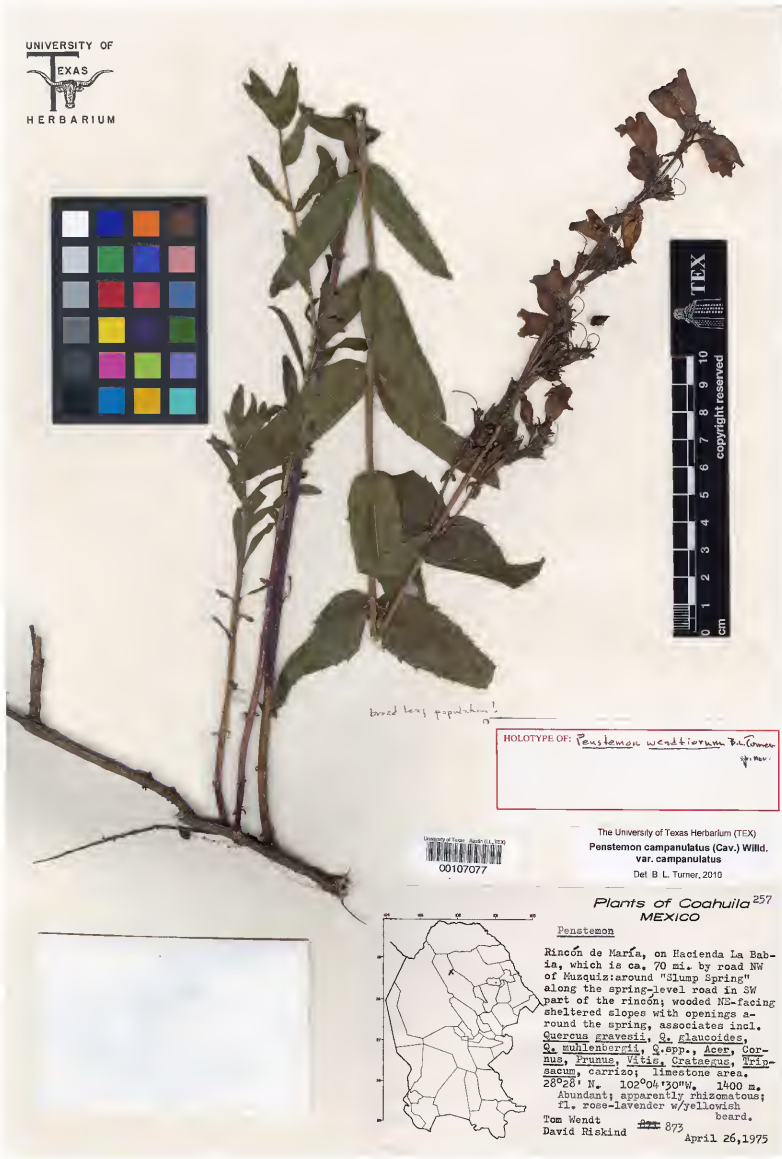


Figure 1. Holotype of *Penstemon wendtiorum*.

Nesom, G.L. 2010. Notes on *Fraxinus profunda* (Oleaceae). Phytoneuron 2010-32: 1–6. Mailed 10 August 2010.

NOTES ON *FRAXINUS PROFUNDA* (OLEACEAE)

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ABSTRACT

A taxonomic overview is provided for *Fraxinus profunda* — including a nomenclatural summary with lectotypes designated for *F. profunda* and the synonymous *F. michauxii*, an updated morphological description including a comparison with *F. pennsylvanica*, and a county-level distribution map. Geographically disjunct records for *F. profunda* in distinctly inland localities (Mississippi and Alabama) are documented; far-inland records from Tennessee and North Carolina were based on collections of *F. biltmoreana*.

KEY WORDS: *Fraxinus profunda*, *F. michauxii*, *F. pennsylvanica*, Oleaceae

Fraxinus profunda occurs primarily along the Atlantic and Gulf coasts into peninsular Florida and in drainages of the Mississippi River and in the Ohio River basin (Little 1977; McCormac et al. 1995). At the northwestern corner of its range, it occurs in bottomlands of the Kankakee River (vPlants 2010), an Illinois/Mississippi River tributary. Limits of the northern range of the species (Michigan, Ontario) have recently been documented in detail (McCormac et al. 1995; Waldron et al. 1996). The trees consistently grow in river swamps and floodplains, especially those seasonally inundated, freshwater tidal wetlands, commonly with bald cypress, swamp cottonwood, and water tupelo. In Illinois, Indiana, Ohio, and northward, they often are found in wet woods and swampy depressions in upland woods as well as till plains and clay lake plains of post-glacial lake beds.

Based on the map from Little (1977), Harms (1990) noted that the range of *Fraxinus profunda* is "quite discontinuous," but addition of recent records shows a more continuous range (Fig. 1). The distribution is ringlike, the southern portion of its range close to the Gulf coast, turning northward along the Mississippi River and then eastward along the Ohio River drainage. Localities in the Carolinas extend inland but reported far-inland records from Tennessee (Marion Co.) and montane North Carolina (Ashe and Swain cos.) have been based on collections of *F. biltmoreana* Beadle. Scattered populations of bona fide *F. profunda* in Georgia (along the Savannah River), Alabama, and Mississippi are considerably inland.

ALABAMA. **Madison Co**.: Redstone Arsenal, ca 4 mi due S of Huntsville, Thiochol Pond, rare in water ca. 2 feet deep, 4 Jul 1980, *Haynes 7946* (NY, VDB); **Pickens Co**.: prairie [weeds] over limestone ca. 1 mi S of Cochrane, 5 Oct 1972, *Kral 48788* (VDB). **MISSISSIPPI**: **Lowndes Co**.: 2 mi S lof Mayhew Junction, Black Belt region, 10-15 m tree along slough, fruit inaccessible, 6 Jun 1970, *McDaniel 13477* (VDB).

Name of the species.

Fernald (1938, p. 451) noted that *Fraxinus profunda* "is so characteristic of the river-swamps and dismals in southeastern Virginia that it seemed improbable that it should have been overlooked by Michaux and other early collectors who went through the region. André Michaux and his son Francois André, it now seems clear, got it and the younger Michaux described and beautifully illustrated it, his plate showing the wholly characteristic foliage with slender petiolules and the quite distinct fruit."

Fraxinus tomentosa F.A. Michx., as the plant illustrated in Plate 9 of Michaux's "Histoire des Arbres Forestiers de l'Amerique," is clearly the species identified here as *F. profunda*. Michaux's description noted that it grows in frequently submerged habitats with other swamp species, including *Nyssa aquatica*. As directly implied by Britton (1905, 1908), however, Michaux's manner of presentation rendered the name *F. tomentosa* superfluous and illegitimate. "The species was illustrated by Michaux as *Fraxinus tomentosa* Marshall, but his accompanying description applies to *Fraxinus pennsylvanica* Marshall, and he cited *Fraxinus pubescens* Lamarck (which is the same as *F. pennsylvanica* Marshall) as a synonym" (Britton 1908, p. 804). "F.A. Michaux similarly changed several other names without justification in the same work" (Little 1952, p. 379). The description of *F. michauxii* Britton (Britton 1905) was intended to provide a valid name for *F. tomentosa* but by that time B.F. Bush already had recognized *Fraxinus profunda* at specific rank.

In North American Trees, Britton (1908) recognized both *Fraxinus michauxii* and *F. profunda*, apparently emphasizing differences in samara morphology (those of *F. michauxii* less compressed and at the lower range of length for the species, as treated here).

Bush (1897, p. 516) explained the origin of the common name. Along Cypress Creek near Varner, Arkansas (Lincoln Co.), where he found *Fraxinus profunda* in abundance, he noted that "My guide told me that the people in the neighborhood call *Fraxinus profunda* Pumpkin Ash on account of its being swell-butted, a character which I had already noted in the trees of Missouri. This Ash grows here to a height of one hundred feet, with a trunk eighteen inches in diameter, and is larger and better developed and more abundant than I have seen it elsewhere."

Fraxinus profunda (Bush) Bush, Gard. & Forest 10: 515. 1897. *Fraxinus americana* var. *profunda* Bush, Annual Rep. Missouri Bot. Gard. 5: 147. 1894. *Fraxinus pennsylvanica* var. *profunda* (Bush) Sudw., USDA Div. Forest Bull. 14: 329. 1897 [non Lingelsh. 1911; not A.E. Murray 1983]. *Calycomelia profunda* (Bush) Niewland, Amer. Midl. Nat. 3: 186. 1914. *Fraxinus pennsylvanica* subsp. *profunda* (Bush) A.E. Murray, Kalmia 13: 6. 1983. **LECTOTYPE**: (designated here): **USA**. Missouri. Dunklin Co.: no other data, 17 May 1892, *B.F. Bush s.n.* (MO!). The label is handwritten by Bush and has "n. sp." in the upper right corner. The sheet includes one complete leaf, the petiole plus rachis 26 cm long, and a packet with samaras.

Protologue: "Abundant in the swamps of Dunklin and New Madrid counties. Sept. So far as can be seen from his figure, the same as Wenzig's *F. platycarpa Floridana*, but it is possible that his figure is actually from young specimens of *platycarpa*. Differs from the usual form of *Americana* in the strong pubescence of the shoots, the large size of the leaves, and the very large fruit, the shaft of which is often strongly six-sided." *Fraxinus platycarpa* var. *floridana* Wenzig is interpreted here as a synonynm of *F. carolmiana* Mill.

Bush (1894) noted that he made several collecting trips to southeastern Missouri (Dunklin and New Madrid counties) to study the swamp flora —May 1892, October and November 1892, April 1893, July 1893, and September 1893 — and specimens of *Fraxinus profunda* at MO can be found for these dates. He observed (pp. 139–140) that "As I was working for the interest of the Missouri Botanical Garden only, I did not collect sets for distribution, but have since put up what duplicates I had left, in a few sets, at the suggestion of Dr. Trelease." Another of the duplicates is at NY!, shown on the NY web site as a potential type: Dunklin Co., 11 Sep 1893, *Bush 89*). The NY specimen is a single leaf, filling the sheet. Bush returned to the same area to collect in 1893, 1894, 1895, and 1897, and duplicates of these are at GH.

Fraxinus tomentosa A.F. Michaux, Hist. Arbr. Forest. 3: 112, pl. 9. 1813 [nom. superfl. illeg.]. **TYPE**: **USA**. "Amer. Sept.," no other information, *M. Michaux s.n.* (P presumably).

Fraxinus michauxii Britton, Man. Fl. N. States (ed. 2), 1075. 1905. **LECTOTYPE** (designated here): **USA.** New York. Bronx, North Meadows, New York Botanical Garden, 15 Jul 1903, *N.L. Britton s.n.* (NY 297191, digital image!; isolectotypes: NY-5 sheets, digital images!). The protologue noted only "Type specimen from a wild tree in the New York Botanical Garden." Britton later added (1908) that "Specimens which were taken as the type of this species were obtained from a wild tree in the north meadows of the New York Botanical Garden, July 2, 1903." All sheets of the "North Meadows" collection at NY are labeled "July 15, 1903;" the reference to "July 2" perhaps was a typographical error.

Six sheets at NY were labelled as isotypes by E.K. Schofield in 1979. Originally there appear to have been 7 duplicates, as there is an empty folder with the other six, noted as "7 of 7 sheets." The 7th sheet appears now to be in the general collection with a pencilled annotation as "merotype" and probably should be returned to the types.

The "North Meadows" of the Botanical Garden formerly included an area, still wooded, of the Bronx River floodplain that is now is part of the Bronx County park system. The tree of from which the type collection of *Fraxinus michauxii* was made has not been relocated and perhaps is dead (fide Michael Nee, NY), but several other large individuals, apparently native, still persist in the immediate area.

Morphology of the species.

Trees, 15–30(–40) m, often forming swollen or buttressed bases under flooded conditions; twigs terete; bark gray-brown, furrowed with blocky and often discontinuous, nearly parallel to reticulate ridges; winter buds brownish. **Leaves** deciduous, pinnate, 20–45 cm, leaflets (5–)7–9, dark green adaxially, paler abaxially, glabrous adaxially, not papillose, densely to sparsely villous-puberulent abaxially over whole surface, only along the midvein and laterals, or less commonly only along the midvein, scaly-punctate to smooth, blades (7–)9–15(–25) cm x (2.5–)3.5–7(–8, –11) cm, broadly lanceolate to ovate-lanceolate, broadly elliptic, or lanceolate-elliptic, apex acute to acuminate, base often rounded or less commonly obtuse to acute or acuminate, margins entire to obscurely serrate, lateral petiolules 5–12(–20) mm, narrowly winged; rachis(5–)8–15 cm; petiole bases not raised; leaf scars broadly obovate to shallowly hemispheric, apex shallowly concave to concave-notched. **Flowers** unisexual (species dioecious), appearing before leaves, wind pollinated; pistillate calyx present and persisting at base of samaras; petals absent. **Samaras** (35–)40–70(–75) mm, body plump and subcylindric to slightly flattened and shallowly channeled, wings 2, gradually expanded from near the base of the body to proximal 1/2, (5.5–)6–10(–12) mm wide. $2n = 138$.

Flowering (Mar–)Apr–May. River swamps and floodplains, especially those seasonally inundated, freshwater tidal wetlands, commonly with bald cypress, swamp cottonwood and water tupelo, wet woods, swampy depressions in upland woods, till plains, clay lake plains of post-glacial lake beds; 10–200 m; Ont.; Ala., Ark., Del., D.C., Fla., Ga., Ill., Ind., Ky., La., Md., Mich., Miss., Mo., N.J., N.Y., N.C., Ohio, Pa., S.C., Tenn., Va.

Palmer (1932) described *Fraxinus profunda* var. *ashei* Palmer, the type from Florida, intending it to represent a glabrous or sparsely pubescent expression of the species. As paratypes, he cited other collections from elsewhere in the range (Georgia, Indiana, Louisiana, Maryland, Missouri, North Carolina, Virginia) that are typical *F. profunda*. The type of var. *ashei*, however, has proved to be a plant of *F. pauciflora* Nutt. (Nesom 2010), and it is possible that other collections have been confused in identification. All collections from Florida, where both species occur in abundance, filed as *F. profunda* should be reexamined to be sure they are correctly identified. The map here (Fig. 1) is based on specimens personally examined as well as some records from literature (as indicated by different symbols).

Leaflets of *Fraxinus profunda* usually are large, characteristically with a rounded base and entire to obscurely serrate margins, and commonly pubescent abaxially at least along midrib and

primary lateral veins, often over the whole surface. Twigs and leaf rachises also usually are pubescent. Leaf scars of *F. profunda* contrast with those of *F. pennsylvanica* in being thinner with a distinctly concave or notched apex. Samaras of *F. profunda* (Fig. 2) are large with thick, wide bodies characteristically dark brown to reddish brown; for smaller-leaved collections, mature fruits may be critical for unambiguous distinction from *F. pennsylvanica*.

1. **Leaflets** (6–)7.5–11(–12) cm long, 2.5–5(–6) cm wide, bases obtuse to acute or abruptly attenuate; **samaras** 20–45(–60) mm long, bodies thickened but not plump, distinctly longitudinally channeled, (12–)15–22 mm long, 1–2 mm wide, tan (similar to wings) to darker brown or rarely reddish-brown, wings arising abruptly from distal 1/4–1/5(–1/2) of body, 4–7(–8) mm wide; fruiting **calyx** 1–1.5 mm long. ..... **Fraxinus pennsylvanica**

1. **Leaflets** (7–)9–15(–25) cm long, (2.5–)3.5–7(–11) cm wide, bases often rounded, less commonly obtuse to acute or acuminate; **samaras** (35–)40–70(–75) mm long, bodies plump, narrowly ridged but not distinctly channeled, (16–)18–30 mm long, 3–4.5 mm wide, dark brown to reddish brown, wings gradually expanded from near the base of the body to proximal 2/3, (5.5–)6–10(–12) mm wide; fruiting **calyx** (1–)4–7 mm long. ..... **Fraxinus profunda**

The chromosome number of *Fraxinus profunda* was reported by Wright (1957) as hexaploid, $2n = 138$. The genome has been hypothesized to be alloploid in origin, derived from a cross between diploid *F. pennsylvanica* and tetraploid *F. americana* (Miller 1955; Wright 1959, 1965), or autoploid from *F. pennsylvanica* (Miller 1955). Hardin and Beckmann (1982), corroborated by Williams and Nesom (2010), showed that the abaxial leaf surface of *F. profunda* is similar to that of *F. pennsylvanica*, without features suggesting an influence of *F. americana*, thus not contradicting an origin through autoploidy. Waldron et al. (1996), however, noted that "The bark on older trees [of *F. profunda*] most commonly develops into solid, continuous ridges similar to those of White Ash and not flaky, broken ridges like those of Red Ash." In the phylogenetic analysis by Wallander (2008), each of three samples of *F. pennsylvanica* appears in a cladistically distinct position on her majority rule consensus tree, and *F. profunda* does not appear as sister to any of the three.

Hardin & Beckmann (1982) noted that very large and asymmetrical scales on the abaxial surfaces is a unique features of *Fraxinus profunda* and provided an SEM photo (their Fig. 23, no voucher cited). I have seen these scales on some collections from Florida, and perhaps they are more common on trees from along the Atlantic coast, but among the specimens I have studied from elsewhere, such scales are rarely present or at least not consistently present.

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Figure 1. Samara variation in *Fraxinus profunda*.

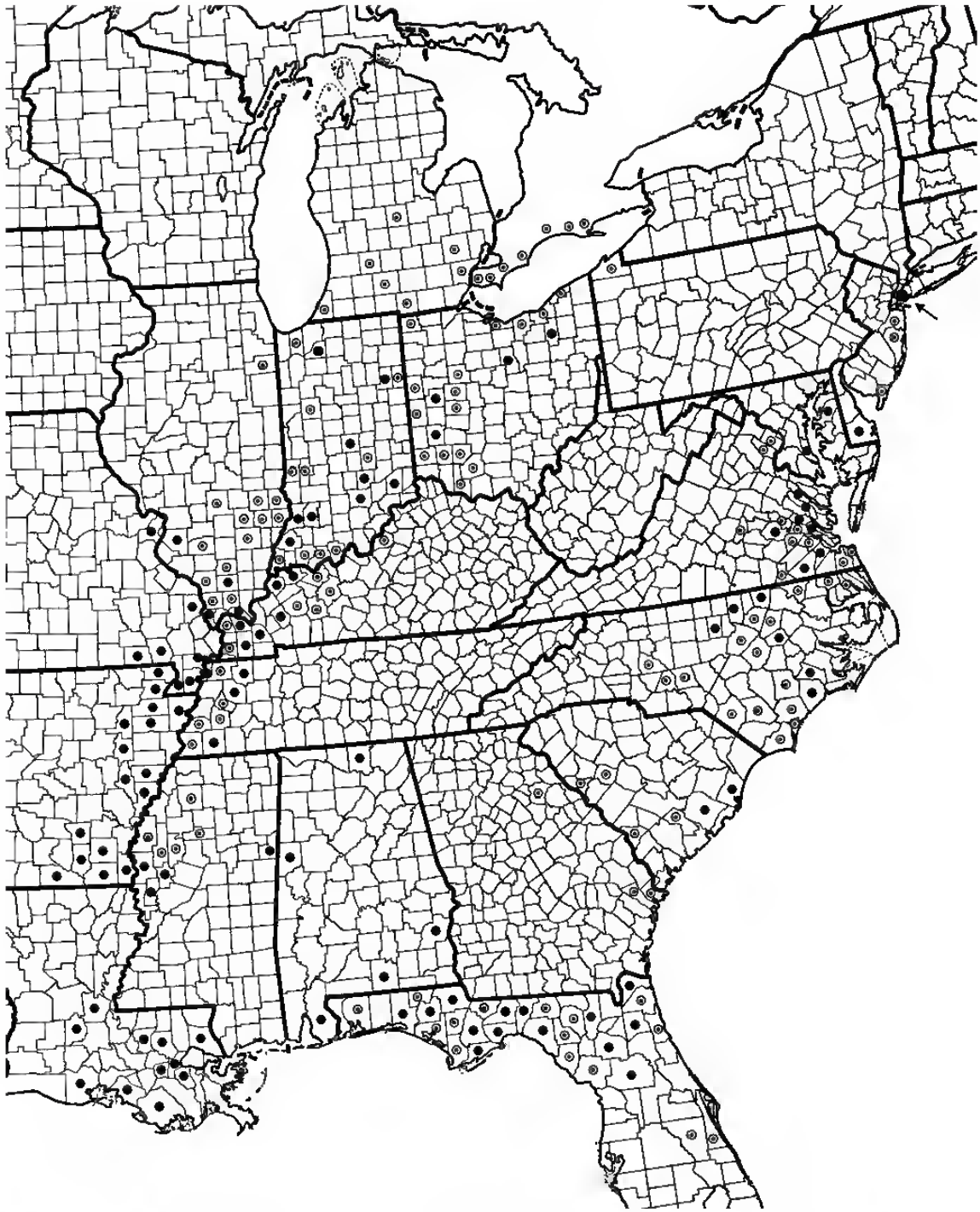

Figure 2. Distribution of *Fraxinus profunda*. Solid circles represent vouchers seen, dotted circles are from literature (as cited in text). The arrow points to Bronx County, New York, the northeastern limit of the species.

Nesom, G.L. 2010. Observations on *Fraxinus albicans* Buckley (Oleaceae), the correct botanical name for Texas ash. Phytoneuron 2010-33: 1–12. Mailed 10 August 2010.

OBSERVATIONS ON *FRAXINUS ALBICANS* BUCKLEY (OLEACEAE), THE CORRECT BOTANICAL NAME FOR TEXAS ASH

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ABSTRACT

Fraxinus americana (eastern North America) and the closely similar Texas ash (Texas, southern Oklahoma, and north-central Mexico) have sometimes been considered to be conspecific, but they are treated here as distinct species. A key contrasting the features of each is provided and the county-level distribution of each is mapped; the distribution of *F. americana* is shown only for Texas and Oklahoma to indicate its parapatry with its close relative. **Fraxinus albicans Buckley** (1863) is the correct botanical name for the species previously identified as *F. texensis* (A. Gray) Sargent (1894). Lectotypes are designated for *F. albicans* and for *F. americana* var. *texensis* A. Gray (= *F. texensis*). Photos of the types are provided.

KEY WORDS: *Fraxinus albicans*, *F. texensis*, *F. americana*, Oleaceae

Fraxinus texensis (A. Gray) Sargent (Texas ash) was mapped by Turner et al. (2003) as a variety of *F. americana* L. (white ash), as originally described by Asa Gray. It was treated as a subspecies of *F. americana* by Miller (1955) but Correll and Johnston (1970), Simpson (1988), and Diggs et al. (1999) treated it at specific rank. Texas ash shares the distinctive abaxial leaf surface found in white ash (Hardin & Beckmann 1982; Williams & Nesom 2009) and also is similar in samara morphology, but Texas ash usually occurs in more xeric habitats along the western margin of white ash (Fig. 1) and is morphologically distinct.

Miller (1955, p. 24) noted that at the southwestern extension of its range, typical *Fraxinus americana* "gives way" to Texas ash (identified by her as *F. americana* subsp. *texensis*) and that "since [Texas ash] is physiologically and ecologically separated from the white ash, and morphologically distinguishable, it is worthy of recognition beyond a mere variant of the white ash." She treated it at subspecific rank because "it apparently does hybridize on occasion with the white ash," listing four collections that she regarded as examples of such hybrids. Each of these four, however, was collected outside of the known range of Texas ash and none is likely to be such a hybrid. Schlesinger (1990) also noted, without documentation, perhaps based on the previous observations by Miller, that white ash and Texas ash intergrade.

The present study corroborates previous observations that Texas ash and white ash are closely similar but discontinous in ecology and morphology. Populational variants within white ash sometimes approach Texas ash in features of fruit or leaf morphology, but it seems clear that two evolutionary entities exist. The two taxa are essentially allopatric or parapatric, with their ranges most closely in contact in south-central Oklahoma. White ash occurs in mesic valleys and bottoms in that area, and true genetic intergrades might be most successfully sought there.

Differences between Texas ash and white ash, as the latter occurs in Texas and Oklahoma, are summarized in the following contrast.

1. Leaf scars 2.5–3(–4) mm wide, depressed obovate, the upper margin shallowly concave to slightly notched with slightly flaring margins; rachises (1–)2–6(–7) cm; leaflet blades 3–6(–8) cm x 2–5 cm, usually suborbicular-ovate to obovate, oblong-ovate, or elliptic, apex abruptly acute to rounded; samaras (12–)15–26(–35) mm long, wings 3–5(–6) mm wide, bodies 5–8 mm long, 1.5–2(–3) mm wide. ..... **Texas ash**
1. Leaf scars 3–4 mm wide, U- or crescent-shaped with a deeply concave or deeply notched apex and narrowly flaring margins; rachises 5–10 cm; leaflet blades 5.5–12(–15) cm x (2–)2.5–6(–7.5) cm, ovate to ovate-lanceolate, elliptic-lanceolate, or oblong-elliptic, apex acute to acute-acuminate or less commonly obtuse; samaras (19–)25–32(–38) mm long, wings 3–5(–6) mm wide, bodies (5–)6–11 mm long, 1.5–2.5 mm wide. ..... **white ash**

Variation in samara morphology in an array from each taxon is shown in Fig. 2a and b. Fruits of white ash are from putatively diploid individuals from Texas, Oklahoma, and Louisiana. A small-fruited form of white ash occurs in scattered localities as variants in diploid populations (Fig. 6), especially in southern states of the USA, and samaras at the small end of the size range for the white ash are much less common than samaras of typical size. Gray (1886, p. 75) commented that some small fruits of *Fraxinus americana* var. *microcarpa* A. Gray (the type from Alabama) were "seemingly full grown but seedless" — all small-fruited collections that I have seen, however, have produced fruits with bodies fully filled by embryos.

Three levels of ploidy occur within *Fraxinus americana*—diploids, tetraploids, and hexaploids — but only diploids reach westward and closely approach the range of Texas ash (Nesom in prep.). A chromosome number has not been reported for Texas ash.

The geographic range of Texas ash is mostly along the eastern portion of the Edwards Plateau in Texas, northward into the Arbuckle Mountains region of south-central Oklahoma, and southward into northern Coahuila and Nuevo León (Fig. 2). It occurs mostly on rocky slopes and bluffs or stream and in canyons and ravines, commonly with cedar elm, juniper, juniper-oak, post oak-blackjack oak, pine-hardwood, or oak-maple. Particularly large individuals of Texas ash are within Fort Worth, Texas, in areas of the Trinity River floodplain that were intermittently flooded until the last 50 years—some of these trees reach nearly 70 feet in height and 100 inches (diameter breast high) in circumference. Typical individuals occur abundantly in nearby upland areas. White ash is widespread in the eastern North America and characteristically occurs in mesic hardwoods communities, on slopes and flats.

Plants in the Davis Mountains of trans-Pecos Texas (Jeff Davis Co.) identified by Palmer (1929, p. 42) as *Fraxinus texensis*, "the commonest species of ash in the Davis Mountains," instead are *F. velutina* Torrey (e.g., *Palmer 30822*, MO; *Palmer 30797*, GH, MO; *Palmer 34343*, GH; *Palmer 34344*, GH). Palmer also identified *F. velutina* as occurring in the Davis Mountains but did not specify his concept of the distinction between the two putative species.

Vouchers for records of Texas ash in Mexico (as mapped in Fig. 1) are given here: **Coahuila**. W side of Potrero de la Mula, ca 20 km NW of Ocampo, on the escarpment near the mines, tree 10 feet tall with oaks on N-facing middle slope, 18 Sep 1941, *I.M Johnston 9222* (GH) and tree 12 ft tall, frequent on N slopes along crest, 18 Sep 1941, *I.M Johnston 9254* (GH); Sierra de Gloria, SE of Monclova, Jul 1939, *Marsh 1870* (GH). **Nuevo León**. Mpio. Villaldama, Rancho Minas Viejas, camino hacia Las Pilas, bosque de *Quercus*, 1170 m, 16 Apr 2001, *Estrada 12399* (BRIT-2 sheets).

The correct botanical name for the Texas ash.

The names *Fraxinus americana* var. *texensis* A. Gray (= *F. texensis*) and *F. albicans* Buckley have been closely associated in concept, as explained below, and their relationship to typical *F. americana* also has been at issue. If the nomenclatural types of *F. americana* var. *texensis* and *F. albicans* are conspecific with each other and not conspecific with the type of *F. americana*, then *F. albicans* of 1863 is the correct name at specific rank for Texas ash, replacing Sargent's *F. texensis* (A. Gray) Sargent of 1894.

Without clear typification, the application of *Fraxinus albicans* has been ambiguous. A possible course toward clarification is to lectotypify it with a specimen of typical *F. americana*, thus allowing retention of the long-used and geographically appropriate *F. texensis* for the primarily Texas trees. The most justifiable interpretation of protologues and specimens, however, as detailed below, indicates that *F. albicans* is the correct botanical name for the Texas ash and should be adopted.

Potential type material for *Fraxinus albicans* at PH includes sheets with a mixture of the Texas ash, white ash with typical-sized fruits, and green ash (*F. pennsylvanica* Marsh.). The mixtures of species were assessed and annotated in 1996 by Achinelli-Delucchi, working out of the Museo de la Plata (LP).

PH-1070637 (Fig. 3): Texas ash, 1 fruiting branch, 2 detached leaves; **white ash**, portion of infructescence, 1 detached leaf. Handwritten label by an unknown hand and above it a shorter one written by Buckley; on both labels, the handwritten epithet "~~negleeta~~" (by Buckley, with the strikethrough) was replaced immediately above it (also by Buckley) by "albicans." Buckley's handwriting is established by comparison with samples in Dorr and Nixon (1985).

The label in unknown hand, probably referring to the detached leaf and infructescence (*F. americana* sensu stricto) immediately above it, has this: "No. 40. White ash. Fraxinus __[Buckley's handwritten names] I am not certain that this is all of the family in our portion of Texas. It is one of our largest and useful timber trees; our wagons, buggies, plough stock, axe handles and and cotton baskets are composed of it. It makes our best flooring plank. To 100 ft. Blooms last of March."

PH-1070637 was collected in Texas, and the small leaflets, characteristic petiole bases (leaf scars), and small fruits clearly serve to identify this collection as Texas ash. Selected here as lectotype.

PH-1070638: white ash, 1 fruiting branch, 1 detached leaf, one detached node with 2 leaves. Handwritten label by Durand(?) noting "*Fraxinus albicans* Buckl.! & no mistake!!!"; the bottom of this label has Asa Gray's annotation of *F. americana* L.!"

This plant has large fruits, relatively large elliptic to elliptic-ovate leaflets, and petiole bases identifying it as typical white ash. Provenance not indicated.

PH-1070639: Texas ash, 1 fruiting branch, on the right; *F. berlandieriana* DC., 1 fruiting branch. Small handwritten label on blue paper by Buckley as "*Fraxinus albicans* Buckl., Texas," although the label is not unambiguously associated with one or the other of the branches.

The branch of Texas ash on PH-1070639 could easily be from the same tree as the designated lectotype (PH-1070637) and is taken here to be an isolectotype.

GH (Fig. 4): Texas ash, 2 detached leaves, 15 fruits. Written on the sheet by Asa Gray: "'F. albicans,' Buckley, the real, or one of them, i.e., reduced F. Americana. Texas. Buckley! ex spec. Durand. = F. Americana,? var. Texensis." Annotated by Miller in 1950 as "*F. texensis* Sarg."

The GH material probably was taken by Gray from the specimen designated here as lectotype of *F. albicans* (PH-1070637, loaned to Gray in 1862 and annotated by him as "Texas. Buckley! ex spec. Durand"), which has a large number of fruits, some attached to the infructescence and some loose. Taken here to be an isolectotype.

Asa Gray's involvement with the Texas ash began almost immediately after Buckley's publication. He borrowed material from PH and quickly published a commentary (Gray 1862).

> "Having for many years past taken a prominent part in the study of Texan botany, as made known by the ample collections of Berlandier, Drummond, Wright, Lindheimer, Thurber, and others, and being under the necessity of keeping, as nearly as possible, *au courant* with all publications upon the subject, I was naturally much interested in the appearance of Mr Buckley's two papers, and not a little surprised at the large number of new species which he had gleaned in such a well-harvested field. Accordingly I applied for specimens of the plants in question, and Mr. Buckley — an early correspondent of Dr. Torrey and myself — promptly and obligingly has placed in my hands, for examination, nearly the whole original materials upon which these new genera and species were characterized." [p. 161]

> "Turning to Mr. Buckley's Texan specimens [of *Fraxinus*] in the herbarium of the Academy, I find there are two, both in fruit; one with the larger larves and fruit is clearly *F. viridis*, var. *Berlandieriana*, Torr., Bot. Mex. Bound. (*F. Berlandieriana* DC.), the other is, I think a form of *F. Americana* (i.e., *albicans* of Buckley), of the small-fruited form we are familiar with, but with very small leaves as well as fruits, the latter terete and cylindrical in the manner of the species." [p. 166]

Thus it appears that Gray studied at least PH-1070639. The material for the GH isolectotype of *Fraxinus albicans* either was sent to GH as a gift, or it could have been taken from PH-1070637, which has a large number of fruits, some attached to the infructescence and some loose. In any case, Gray's assessment at the time was that the Texas ash should be identified as *F. americana* and he roundly castigated Buckley, noting that he "had no need to give a new specific name to the white ash." Later, Gray (1886) did recognize the Texas ash as a distinct entity.

Fraxinus albicans Buckley, Proc. Acad. Nat. Sci. Philadelphia 14: 4. 1862. *Fraxinus americana* var. *albicans* (Buckley) Lingelsh., Mitt. Deutsch. Dendrol. Ges. 1911: 184. 1911. **LECTOTYPE** (designated here; Fig. 3): **USA.** Texas. No other information, *S.B. Buckley s.n.* (PH-1070637 digital image!; isolectotypes: GH! "ex spec. Durand" (Fig. 4), PH-1070639 digital image!). See detailed notes below regarding the lectotype, isolectotypes, and other type material. Miller (1955, p. 36) noted that the type of *F. albicans* ["in part"] was at PH but did not cite or allude to any particular specimen or collector.

Protologue (excl. description): "It is found from New England to Texas, being the largest of the American ash trees, sometimes attaining a diameter of between four and five feet. Its bark is furrowed and of a light grey; hence it is called the white ash in many places. Its petioles are grooved, and its buds are destitute of the red velvety pubescence peculiar to *F. americana*. I have not seen it in the vicinity of Phildelphia, nor is there any specimen of it collected in this neighborhood in the herbarium of the Academy. In the herbarium of Darlington, at West Chester, I saw specimens of it labelled *F. americana*, and it is probably thus called by other American botanists. The West Chester collection had no specimens of *F. americana* or *F. pubescens*. [paragraph] Both *F. americana* and *F. albicans* being called white ash throughout the counry have caused them to be confounded, especially where, as is often the case, they do not both grow in the same locality; but the fruit of the latter is only about half the size of the former, which, with the other distinctions enumerated, show that they are very different species."

Fraxinus americana var. *texensis* A. Gray, Syn. Fl. N. Amer. (ed. 2) 2(1): 75. 1886. *Fraxinus texensis* (A. Gray) Sargent, Silva 6: 47. 1894 [nom. superfl. illeg., in the interpretation here that it is conspecific with *Fraxinus albicans* Buckley 1862]. *Fraxinus americana* subsp. *texensis* (A. Gray) G.N. Miller, Cornell Expt. Station 335: 36. 1955. **LECTOTYPE** (designated here; Fig. 5): **USA**. Texas. [Val Verde Co.:] Cañon of Devil's River, 16 Sep 1852, *J.M. Bigelow s.n.* (GH!; isolectotype: NY digital image!). The GH sheet is annotated in Gray's handwriting, on a "Syn. Fl. N. Amer." annotation label, as "F. americana var?. texensis."

Protologue (excl. description): "*F. albicans*, Buckley, l. c., in part. *F. pistaciaefolia*, E. Hall, List. Pl Tex. no. 527. *F. cortacea*, Watson, l. c., as to pl. Bigelow, "Devil's Run Cañon," Texas (not "Arizona"). … Texas, on rocky hills, from Austin to Devil's River, near the Rio Grande. Perhaps a distinct species." A syntype is from Travis Co.: Austin, rocky hill, 13 May 1872, *E. Hall 527* (GH!, NY digital image!).

An internal contradiction in Buckley's protologue for *Fraxinus albicans* causes a difficulty in interpretation. Buckley noted that *F. albicans* is a large tree ranging widely in eastern North America—this does not characterize the Texas ash, in which the trees are mostly relatively smaller in size and geographically restricted. In contrast, he observed that the fruits of *F. albicans* are about half the size of those of *F. americana* — this is truer of the Texas ash, although atypically small fruits also are produced in scattered localities in typical *F. americana* over its wider range (see comment below). From the protologue observations, it appears that Buckley's concept of *F. albicans* included the Texas ash and the small-fruited forms of typical *F. americana*. In Buckley's type material of *F. albicans*, however, the small-fruited form is represented only by trees of the Texas ash. Typical *F. americana* is represented (on two of the Buckley sheets at PH) by trees with larger fruits.

In the original description of *Fraxinus americana* var. *texensis*, Gray (1886, p. 75) cited "*F. albicans*, Buckley, l.c., in part" as a synonym. Immediately above, on the same page, he cited "*F. albicans*, Buckley in Proc. Acad. Philad. 1862, partly" under *F. americana* var. *microcarpa* A. Gray. Gray's partition of the concept of *F. albicans* appears to reflect his understanding that the taxon in the sense of Buckley's protologue and type material included an entity from Texas as well as from the eastern USA. Gray's comments of 1886 did not refer to a specimen, but he had seen at least one of the associated Buckley collections from PH (see comments above regarding the GH isolectotype of *F. albicans*) and acquired for GH a sample of fruits and leaves representing the Texas ash. Gray clearly associated Buckley's type material with the Texas ash, the Texas "part" of the *F. albicans* concept. The other "part," var. *microcarpa*, will be lectotypified by a Curtiss collection from Alabama (Nesom in prep.), which represents a small-fruited populational variant of typical *F. americana* (see example in Fig. 6).

When Sargent (1894) raised *Fraxinus americana* var. *texensis* to specific rank, he cited in synonymy "Fraxinus albicans, Buckley, Proc. Phil. Acad. 1862, 4 (in part)," repeating Gray's partitioned concept. Because the correspondence was clear between var. *texensis* and its associated "part" of *F. albicans*, Sargent's use of *F. texensis* at specific rank is interpreted here as a superfluous substitution for the earlier *F. albicans*, rendering his combination illegitimate. Lingelsheim (1907, 1920) and Miller (1955) also have considered *F. albicans* conspecific with *F. americana*. Miller repeated the "*F. albicans* Buckley in part" phrasing in listing it as a synonym, but Lingelsheim (1920) recognized *F. americana* var. *albicans* and unequivocally cited *F. albicans* Buckley and *F. americana* var. *texensis* A. Gray as synonyms.

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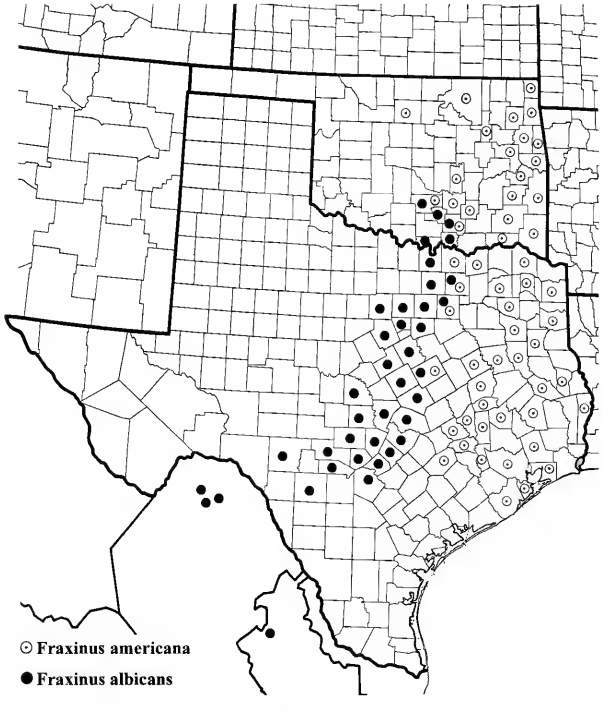

Figure 1. Distribution of the Texas ash, *Fraxinus albicans* (see text regarding the epithet). The distribution of *F. americana* is shown for Texas and Oklahoma to indicate its parapatry with *F. albicans*.

Figure 2 Samara variation Top two rows Texas ash (*Fraxinus albicans*) in Texas and Oklahoma Bottom two rows typical diploid white ash (*Fraxinus americana*) in Texas Oklahoma, and Louisiana

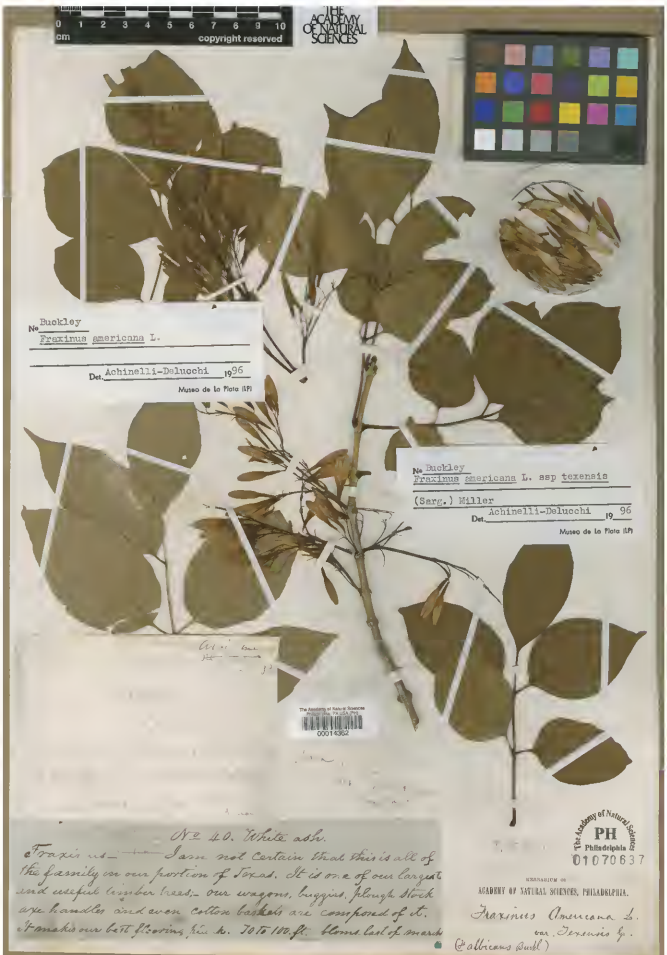

Figure 3. Lectotype of *Fraxinus albicans* (PH). Detatched leaves at bottom right and top left, fruiting branch, loose fruits. See comments in text.

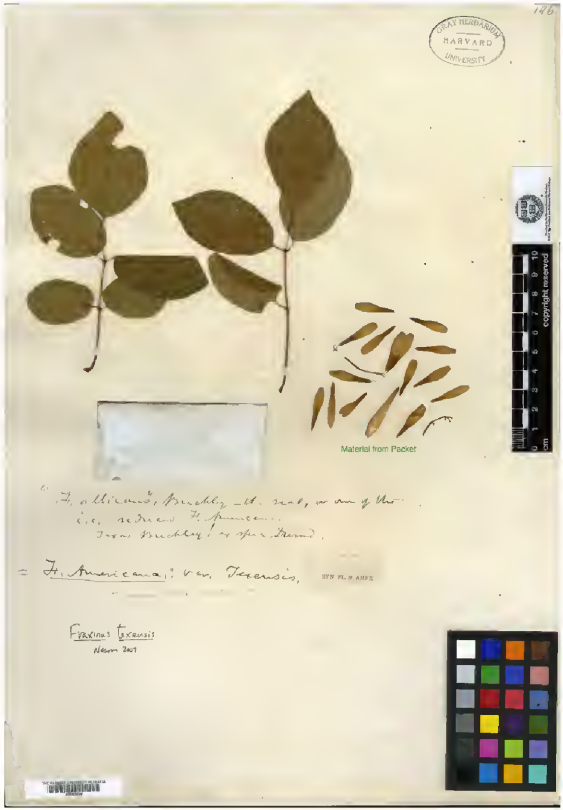

Figure 4. Isolectotype of *Fraxinus albicans* (GH). See comments in text.

Figure 5. Lectotype of *Fraxinus americana* var. *texensis* (GH). See comments in text.

Figure 6 *Fraxinus americana* with atypically small samaras (from Morgan Co , Tennessee) Such individuals sometimes have been identified as *F. americana* var *microcarpa* (see text)

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Mailed 10 August 2010.

TAXONOMIC NOTES ON *FRAXINUS BERLANDIERIANA* AND *F. VELUTINA* (OLEACEAE)

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ABSTRACT

The concept of *Fraxinus berlandieriana* has been applied mostly to trees in the Rio Grande plains of south Texas and adjacent Mexico. An expanded range is recognized here to include counties along the eastern edge of the Edwards Plateau and as far north in Texas as Dallas and Tarrant counties and slightly disjunct further northward to Stephens Co., Oklahoma. *Fraxinus velutina* and *F. pennsylvanica* are closely similar to *F. berlandieriana* — the Texas distributions for all three are mapped and synonymy and typification are provided for *F. velutina* (including *F. papillosa*). Lectotypes are designated for *Fraxinus attemuata*, *F. berlandieriana*, *F. papillosa*, *F. pubescens* var. *lmdhemeri*, *F. toumeyi*, *F. trialata*, and *F. velutina* var. *glabrata*.

KEY WORDS: *Fraxinus berlandieriana*, *F. velutina*, *F. papillosa*, *F. pennsylvanica*, Oleaceae

Fraxinus berlandieriana DC. has been treated at specific rank by Texas botanists and most others (eg., Standley 1924; Vines 1960; Preston 1961; Correll & Johnston 1970; Elias 1980; Cox & Leslie 1988; Simpson 1988), although its distinction from *F. pennsylvanica* Marsh. has not been critically studied. The two rarely have been directly compared. Miller (1955), in contrast, treated *F. berlandieriana* as a synonym among many others within her concept of *F. pennsylvanica*.

Wide variability exists within *Fraxinus pennsylvanica* and it is generally recognized in current treatments without formal infraspecific variants, although many have been named. Some of the formally named variants are accounted for below; others are given by Wunderlin and Hansen (2010). Miller (1955) further broadened the concept of *F. pennsylvanica* to include at subspecific rank *F. velutina* Torr. of the southwestern USA. and northwestern Mexico and *F. latifolia* Benth. of California, Oregon, Washington, and British Columbia. In Miller's view, trees of eastern North America are subsp. *pennsylvanica*.

Two varieties of *Fraxinus pennsylvanica* sensu stricto often are recognized: var. *pennsylvanica* (red ash) with tomentose to puberulent twigs, petioles, rachises, and leaf surfaces and var. *subintegerrima* (green ash; synonym var. *lanceolata*) with glabrous twigs and leaves and narrower leaflets. The two appear to be completely sympatric, however, over the range of the species, although they may sort ecologically in some places or at least small enclaves of one expression or the other may occur in some areas. Study of infraspecific variation in *F. pennsylvanica* remains an interesting and potentially informative prospect.

The nomenclatural implication by Miller (1955) that *Fraxinus berlandieriana* is more similar to *F. pennsylvanica* than is *F. velutina* or *F. latifolia* is correct, but *F. berlandieriana* can be recognized as morphologically and geographically distinct. Intermediates perhaps occur where the two are sympatric, but the geographic transition seems abrupt. Jones (1975) recognized the occurrence of both species in the Texas Coast Bend. Both species have been collected in Travis County, Texas, and I have observed both in relatively close proximity in Fort Worth, Tarrant County.

Miller (1955) saw the distributions of *Fraxinus pennsylvanica*, *F. berlandieriana*, and *F. velutina* as a geographic continuum, which is contradicted here (Fig. 1). She noted (p. 18) that "Where the velvet and the red ash [*F. velutina* and *F. pennsylvanica*] meet, … a significant number of individuals are not clearly the velvet or the red ash. Many of these intermediate specimens have been identified in the past as *F. berlandieriana*. Since hybridization seems to occur, indicating a lack of sterility between these two ashes where they are in contact, … the author has reduced the velvet ash to a subspecific level." She observed (by annotation, SMU) *F. velutina* as extending eastward to the Rio Grande plains, and in her view, typical *F. berlandieriana* was "a variation of red ash."

Fraxinus berlandieriana differs from *F. pennsylvanica* in its leaves with fewer leaflets and smaller petiole bases and in its sporadically 3-winged samaras with wings originating from a lower point along the body (see key below). The occurrence of 3-winged samaras was noted by De Candolle in the protologue ("Samarae … rarius triquetrae"), later by Gray (1878), and was beautifully illustrated by C.E. Faxon in Sargent (1894, Tab. 273). As also is the case in *F. caroliniana* Miller, 3-winged fruits are produced in low frequencies (5–10%) on trees with primarily 2-winged fruits, or some trees apparently produce only 2-winged fruits. Both species characteristically occur in riparian and bottomland communities and both produce samaras with strongly flattened bodies with 2–3 smooth and shallow longitudinal channels. Trees of *F. berlandieriana* are (20–)25–60 feet tall; those of *F. pennsylvanica* may range up to 80 feet but smaller trees in the height range of *F. berlandieriana* are common, and in Texas, green ash trees are described (from label data) as (15–)20–40 feet tall.

Fraxinus berlandieriana has generally been considered to be a species of the Rio Grande plains of south Texas (e.g., Turner et al. 2003) and adjacent Mexico. It has been noted to occur "in the Edwards Plateau" (Correll & Johnston 1970) or in the "southern Edwards Plateau" (Cox & Leslie 1988). Simpson (1988) mapped it as disjunct in Travis and Bastrop counties from a more southern distribution. In the present study, trees with 3-winged fruits and predominantly 3–5 leaflets with distinctly serrate distal margins are observed to occur in Texas along the eastern edge of the Edwards Plateau to as far north as Tarrant and Dallas counties (Fig. 1). In some cases, these were correctly identified by the collectors as *F. berlandieriana*.

Similarly, a collection from south-central Oklahoma is identified here as *Fraxinus berlandieriana* — at the northern extremity of its range and apparently slightly disjunct from those in Texas to the south. **Oklahoma**. Stephens Co.: Magnolia Creek, Little Beaver Creek, 8 mi W of Duncan, valley forest of *Celtis*, *Ulmus*, *Carya*, 1100 feet, near stream banks, large tree 60 feet, common, 29 Oct 1980, *Little 36340* (OKLA). The collector noted "a few fruits 3-winged," and these are clearly observable on the specimen. The leaflets are 3–5 on rachises 4–6 cm long, and the petiole bases are relatively shallow and apically concave. From the same locality Little collected a specimen of *F. pennsylvanica* (*Little 36308*, OKLA), noting that it was taken from a "shrub" and calling attention to the comparison with *36340* — it is sterile, but the leaflets are 5–7 on rachises 12–16 cm long, and the petiole bases (leaf scars) are distinctly shield-shaped, typical of *F. pennsylvanica*.

1. Leaflets 3–5, coriaceous to subcoriaceous, (4–)5–9.5 cm x (1.5–)2–4 cm, margins coarsely and sharply serrate on distal 1/2–2/3; leaf scars shallowly hemispheric, 2.2–3 mm wide, apex shallowly concave; samaras mostly 2-winged but often 3-winged among the 2-winged ones, wings gradually expanded from the base to distal 1/3 of body and narrowly flanging the body. ..... **Fraxinus berlandieriana**

1. Leaflets 5–7(–9), subcoriaceous to submembranous, (6–)7.5–11(–12) x 2.5–5(–6), margins subentire to inconspicuously dentate-serrulate; leaf scars shield-shaped, broadly oblong-ovate, 3–4 mm wide, apex truncate to very shallowly concave; samaras consistently 2-winged, wings abruptly expanded from distal 1/4(–1/2) of body. ..... **Fraxinus pennsylvanica**

Differences between *F. berlandieriana* and *F. pennsylvanica* are subtle, and further study in field and lab will provide a more certain resolution of their distinction and evolutionary status. A collection from Refugio Co., Texas (23 Jul 1989, *Jones 3595*), was identified as *F. berlandieriana* and used by Wallander (2008) as a voucher for her molecular study, but it is *F. pennsylvanica*. Collections from Hidalgo, Mexico, sometimes identified as *F. berlandieriana* are apparently not that species. One such, *Pringle 9417* (Hidalgo, valley near Dublan), is the type of *F. pringlei* Lingelsh; another from Hidalgo of the same species, *Pringle 13584,* was used by Wallander (2008) as a voucher of *F. berlandieriana* for molecular analysis.

Fraxinus berlandieriana DC. [as "berlanderiana"], Prodr. 8: 278. 1844. *Fraxinus viridis* var. *berlandieriana* (DC.) A. Gray, Rep. U.S. Mex. Bound. 2(1): 166. 1859. *Fraxinus pubescens* var. *berlandieriana* (DC.) Wenzig, Bot. Jahrb. Syst. 4: 183. 1883. *Fraxinus americana* var. *berlandieriana* (DC.) Wesmael, Bull. Soc. Bot. Belgique 31: 108. 1892. *Fraxinus viridis* forma *berlandieriana* (DC.) Voss, Vilm. Blumegärtn. (ed. 3) 1: 645. 1894. **LECTOTYPE** (designated here): **USA. Texas**. "Orillas del Rio de las Nueces, Julio 1829, *M. Berlandier 1832, No. 2012* (G-DC, fiche!; isolectotype: G-DC fiche!, GH!). The label of the G-DC duplicate says "Tamaulipas, *M. Berlandier 1832, 2012*." The GH specimen label says "Rio de las Nueces, alt. 20–25 feet, Jul 1829, *Berlandier 2012/602*." Two further duplicates with the "602" label are at US: "*602 Berland*., Nueces" (US 96047, digital image!), is further noted as "From Berlandier's specimen in herb. Gray;" another sheet (US 40778, digital image!) has only the number "602." A duplicate of the 602 collection also is at PH (fide the PH online type database), label information as "Orillas del Rio de las Nueces" in Texas; another is at NY (NY 297176, mounted opposite *Berlandier 2122*), labeled as "Hab. Nueces - Texas." All of the "602's" are also perhaps duplicates of the lectotype. Another possible isolectotype is *Berlandier 2112* (NY 297175, digital image!, no locality or date, mounted with *Berlandier 602*); "2112" is perhaps a mistranscription of "2012."

The protologue notes "in Mexico prov. Tamaulipas, ad villam Austin, et Texas ad Orillas del Rio de las Nueces legit cl. Berlandier. … (v.s. sp. a cl. inv.)" In addition to the lectotype and duplicate, another specimen (syntype) of *F. berlandieriana* is in G-DC (fiche!): "Villa de Austin, Texas, *Hay 1688*." A NY sheet has this label information: "Mexico, prov. Tamaulipas, ad villam Austin, etc. Legit *J.L. Berlandier, n. 2012*."

Berlandier's diary (Berlandier 1980) indicates that the only time in 1829 that he crossed the Nueces River was on June 24th, apparently in north-central Dimmit County, as indicated on Fig. 1. He did not mention the collection of ash but the both the G-DC and GH types, which are fruiting, are indicated to have been collected in July.

Fraxinus pubescens var. *lindheimeri* Wenzig, Bot. Jahrb. Syst. 4: 184. 1883. **LECTOTYPE** (designated here): **USA. Texas**. [Comal Co.:] No other label data, 1847, *F. Lindheimer 653* (SMU!; isolectotypes: BRIT-2 sheets!, GH-3 sheets!, MO!, PH, SMU!, US-digital image!). Wenzig cited simply "F. Lindheimer 653!"; the Oleaceae at B, where Wenzig's herbarium and types were deposited, were destroyed. The lectotype has a handwritten label by Lindheimer: "Am Flussufer und im feuchten Bottomwäldern mittlereg Cursus."

Fraxinus trialata Buckley, Proc. Acad. Nat. Sci. Philadelphia 1862: 5. 1863. *Fraxinus viridis* var. *trialata* (Buckley) Schelle, Handb. Laubholzben., 408. 1903. **LECTOTYPE** (designated here): **USA. Texas**. [Atascosa Co.:] "Atascosa," no other information, *S.B. Buckley s.n.* (PH 1070650 digital image!). **Protologue**: "A shrub or small tree, 15–20 feet high, growing on the banks of the Atascosa River in Western Texas." "Samaras in loose axillary or terminal panicles, about one-half of them 3-winged, and 2–3 lines broad in the widest portion; not terete below; the wings being attenuated as far as the pedicels." The type is mounted on a sheet with young branches of what apparently is *Fraxinus albicans* Buckley (= *F. texensis*) from Hays County, Texas. The label, apparently in Durand's handwriting, says "Fraxinus trialata Buckl., Atascosa, Texas."

Flowering Feb–Mar(–Apr). Pond and lake edges, creek and river banks, among boulders in rivers, alluvial terraces, low woods, canyons, disturbed sites; (5–)50–1300 feet; Okla., Tex.; Mexico (Coahuila, Nuevo León, San Luis Potosí, Tamaulipas, Veracruz). Mexican ash, fresno.

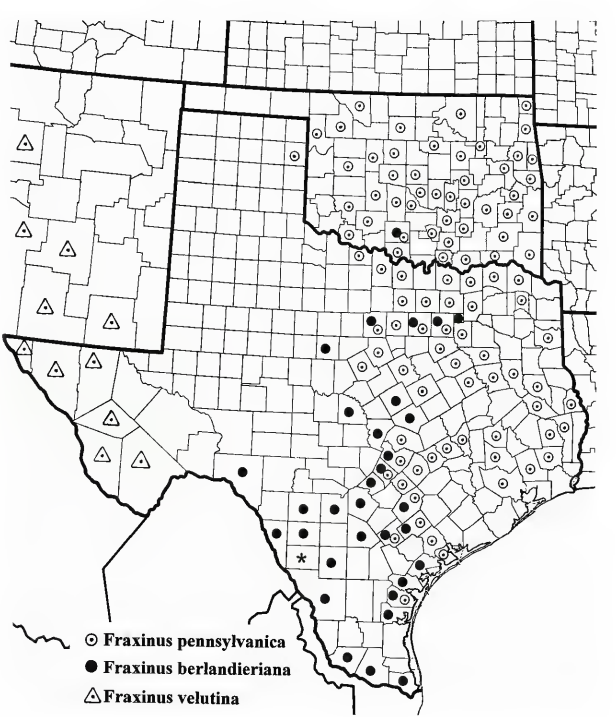

Figure 1. Distribution of *Fraxinus pennsylvanica*, *F. berlandieriana*, and *F. velutina* in Texas and Oklahoma. The asterisk is in Dimmit Co., Texas, from where the type collection of *F. berlandieriana* was made. The distributions of *F. berlandieriana* and *F. velutina* continue into Mexico and *F. velutina* continues to Arizona and southern Utah (see map in Williams and Nesom 2010).

Sargent (1894, p. 54) observed for *Fraxinus berlandieriana* that "For centuries it has been planted in the cities of the Mexican table-land, except in those of Chihuahua, and their parks and places are often dignified by single individuals or noble avenues of this species, which no other Ash-tree surpasses in stateliness and beauty."

Collections of *Fraxinus berlandieriana* from Mississippi have been distributed and apparently are the basis for citation of the species as naturalized there (USDA, NRCS 2010), but these samples are not from a naturalized tree. Bolivar Co.: planted tree beside railroad tracks west of US 61 in downtown Shelby, 12 Jun 1992, *Thomas 129,794* (BRIT, NLU, NY); Shelby, W of US Hwy 61, along abandoned RR track in downtown Shelby, 14 Sep 1990, *Bryson 10380* (MO, VDB-6 sheets). The ten specimens are very similar among themselves and perhaps were all taken from a single tree, noted by collector R.D. Thomas to have been planted. The leaflets are narrower than characteristic for the species in Texas, but the identity seems clear. Of a total of 84 samaras among all the samples, 9 are 3-winged; leaflets (3–)5, narrowly elliptic-lanceolate, 6–9(–11) cm long, margins sharply dentate-serrate on distal 1/3-4/5, glabrous on both surfaces. I also have seen vouchers (BRIT, NLU, VDB) for *F. berlandieriana* in cultivation in Monroe and New Orleans, Louisiana, where it apparently is commonly grown, but naturalization of the species in Louisiana is not confirmed in this study. Collections from Monroe apparently are the basis for its citation as naturalized in Louisiana (USDA, NRCS 2010).

Bessey (1914) reported that "certain green ash trees (*Fraxinus pennsylvanica*) in Lincoln [Nebraska] regularly bear a few tricarpellary fruits." No vouchers were cited but it is possible or even probable that these were cultivated trees of *F. berlandieriana*. I have not seen tricarpellate fruits produced by *F. pennsylvanica*.

Fraxinus velutina — variation and typification.

Variation in *Fraxinus velutina* Torr. has prompted the naming of various taxa at specific and infraspecific rank, but all appear to be intergrading and usually are maintained without formal recognition within the single species. Leaflets in Texas and most of New Mexico are mostly ovate-lanceolate to ovate-elliptic or oblanceolate-obovate. They tend to be narrower—more lanceolate and often with an attenuate apex—in southwestern New Mexico and Arizona, where the plants have sometimes been identified as var. *toumeyi*. Miller observed that "local populations may tend to one end or the other of this range, but both types and all possible intermediates are general throughout the range of [*F. velutina*]." Leaflet vestiture across the range of the species typically is sparsely to moderately short-villous, especially abaxially along the veins and axils, but glabrous forms occur throughout the range. Most trees in Jeff Davis Co., Texas, have glabrous leaves but from one population along Limpia Creek near Fort Davis, one tree had glabrous leaves (*Correll & Johnston 18384*, LL) and one had leaves short-villous abaxially (*Correll & Johnston 18385*, LL).

Miller (1955) observed that significant variation in samara body shape occurs in *Fraxinus velutina*, particularly in New Mexico (as typified by *F. standleyi*), where thicker bodies approaching those of *F. americana* or *F. texensis* are produced. In the observation here, thick bodies actually are fairly typical of *F. velutina* as a whole, compared to *F. pennsylvanica* and *F. berlandieriana*. The samara bodies are terete at the base, and while they are thick-ridged, the bodies are usually not distinctly flattened.

Fraxinus coriacea S. Wats. has often been treated as a synonym of *F. velutina*, but it has been recognized as morphologically and geographically distinct (Nesom 2010).

Fraxinus velutina is variable in the prominence of a cuticular overlay on the abaxial leaf surfaces. Those with a thicker overlay and whitish cast abaxially are mostly in Chihuahua, Sonora,

and Arizona and have previously been identified as *F. papillosa*, but they are intergradient with *F. velutina* and *F. papillosa* is regarded as a synonym of *F. velutina*. The abaxial cuticular surface of *F. papillosa* is not at all "papillose" like the leaves of *F. americana* and its close relatives. The foliar features are discussed in detail and documented by SEM photos in Williams and Nesom (2010).

Fraxinus velutina Torr. in Emory, Notes Milit. Reconn., 149. 1848. *Fraxinus pennsylvanica* subsp. *velutina* (Torr.) G.N. Miller, Cornell Agric. Expt. Sta. Mem. 335: 40. 1955. *Fraxinus pistaciifolia* Torr. [nom. nov. illeg.], Pacific Railr. Rep. 4(5): 128. 1856. *Fraxinus americana* var. *pistaciifolia* (Torr.) Wenz., Bull. Soc. Roy. Bot. Belgique 31: 108. 1892. *Calycomelia pistaciifolia* (Torr.) Nieuwl., Amer. Midl. Naturalist 3: 187. 1914. **LECTOTYPE** (Rehder 1917): **USA. New Mexico**. Sierra Co.: between the waters of the Del Norte and the Gila, 15 Oct 1847, *W.H. Emory s.n.* (NY!, digital image!, photo-GH!). The NY sheet is marked 15 Oct "1846" (the last digit in the year barely legible), but it is the sheet apparently annotated by Torrey first as *F. velutina*, then later as *F. pistaciifolia* (see below). Holmgren (1984) referred to the NY sheet as the "holotype."

A specimen (fragment package) at GH is labeled "On the Mimbres, 15 Oct 1847, *W.H. Emory, Jr. s.n.*" and is noted in the GH database as "Fragment ex Herb. Torrey (NY)." The protologue noted "Grows in the region between the waters of the Del Norte and the Gila; also on the Mimbres, a tributary of the latter river."

In the protologue of *Fraxinus pistaciifolia*, Torrey cited *F. velutina* in synonymy, his epithet "pistaciaefolia" an explicit substitution for the earlier one: "A species occurring in almost all the New Mexico collections, excessively variable in its foliage, and so much more generally smooth than pubescent (still less velvety) that we propose to supercede the little-known name under which an extreme form of it was briefly described in Emory's Report some years ago."

A US specimen (digital image!) was annotated as "Type" by E.L. Little in 1951: California. [no other information on label,] *J.M. Bigelow s.n.* The sheet was further annotated by Little with the observation that the specimen is a mixture of *F. cuspidata* var. *macropetala* and *F. velutina*. "California" is printed on the original label, but Little's annotation indicates that it was collected in "Arizona, Jan 3, 1854."

Fraxinus papillosa Lingelsh., Bot. Jahrb. Syst. 40: 219. 1907. **LECTOTYPE** (designated here): **Mexico**. **Chihuahua**. Colonia Garcia, 7000 ft, 29 Sep 1899, *C.H.T. Townsend and C.M. Barber 354* (US 00735371 digital image!; isolectotypes: BM digital image!, E digital image!, GH, K digital image!, MO!, NY! digital image!, US 347148 digital image!). Lingelsheim cited only *Townsend & Barber 354*!, without specifying the specimen location; he may have had a specimen at Breslau (Wroclaw, WRSL), where he worked. The isolectotype at GH was not located in 2009, but a photo of the GH sheet is on file and a fragment package from the GH sheet is mounted and filed with the types.

Fraxinus toumeyi Britton in Britton & Shafer, N. Amer. Trees, 803, fig. 732. 1908. *Fraxinus velutina* var. *toumeyi* (Britton) Rehder, Proc. Amer. Acad. Arts 53: 204. 1917. **LECTOTYPE** (designated here): **USA. Arizona**. Pima Co.: Tucson, October 1895, *J.W. Toumey s.n.* (NY! digital image!; isolectotypes: US-2 sheets digital images!). Two separate collections are mounted on each of the three sheets—one branch in flower with small, developing leaves (collected March) and one sterile with fully mature leaves (collected October). The protologue notes that "The type specimens were collected by Professor J.W. Toumey of the Yale Forest School, at Tucson, Arizona, March and October, 1895," referring to the pair of collections (syntypes) on each sheet. The collection made in October is designated here as the lectotype.

Fraxinus attenuata M.E. Jones, Contrib. W. Bot. 12: 59. 1908. **LECTOTYPE** (designated here): **Mexico**. **Baja California**. Valley of Palms, 8 Apr 1882, *M.E. Jones 3741* (US 01083329 digital image!; isolectotypes: GH!, MICH digital image!, MO!, US 220686 digital image!).

The protologue also cited a syntype: Arizona. [Pima Co.:] Catalina Mts., 15 Jun 1903, *Thornber s.n.* (RSA). A specimen of *Jones 3741* was not located at RSA-POM, fide Sula Vanderplank at RSA).

Fraxinus velutina var. *glabra* Rehder, Proc. Amer. Acad. Arts 53: 207. 1917. **TYPE**: **USA. Arizona**. Pima Co.: Range Reserve, 21 Jul 1911, *E.H. Wooton s.n.* (holotype: US 690667 digital image!; isotype: US 660964 digital image!). Rehder cited the unpublished "*Fraxinus glabra* Thornber in U. S. Herb." as a synonym—the handwritten labels of the two US type sheets were supplied with the identification of "*Fraxinus glabra* Thornber sp. nov."

Fraxinus standleyi Rehder, Proc. Amer. Acad. Arts 53: 208. 1917. **TYPE**: **USA. New Mexico**. Dona Ana Co.: Organ Mts., Van Pattens Camp, 9 Jun 1906, *P.C. Standley s.n.* (holotype: US 560835 digital image!, photo-GH!; isotype: US 564379 digital image!).

Fraxinus standleyi var. *lasia* Rehder, Proc. Amer. Acad. Arts 53: 210. 1917. **TYPE**: **USA. Arizona**. Coconino Co.: Oak Creek Canyon, S of Flagstaff, 5500 ft, 15 Sep 1916, *A. Rehder 585* (holotype: GH!).

Fraxinus velutina var. *glabrata* Lingelsh., Pflanzenr. 4, 243(Heft 72): 43. 1920 [nom. illeg., non Rehder 1917]. **LECTOTYPE** (designated here): **Mexico**. **Baja California**. Valley of Palms, 8 Apr 1882, *M.E. Jones 3741* (US 01083329 digital image!; isolectotypes: MO!, US 00220686 digital image!). Lingelsheim worked at Breslau (Wroclaw, WRSL) and may have seen a specimen there, but the protologue cited only "Die varietät scheint auf Mexiko beschränkt zu sein. (Jones n. 3741, Endlich n. 164!, 164a!)." With selection of *Jones 3741* as the lectotype, *F. velutina* var. *glabrata* becomes homotypic with *Fraxinus attenuata* M.E. Jones (see above).

Flowering Mar–Apr. Canyons, streambanks, yellow pine woodland, chaparral, riparian woods; (200–)600–2100 m; Ariz., Calif., N.Mex., Tex., Utah.; Mexico (Baja California, Chihuahua, Coahuila, Nayarit, Nuevo León, Sonora). Arizona ash, velvet ash, desert ash, fresno.

Plants identified as *Fraxinus velutina* from Comanche Co., Oklahoma, by Miller (1955) are identified here as *F. pennsylvanica* — in a county where the latter is very common (*Clemens 11725a*, GH) and where *F. velutina* would be far out of range. Collections of *F. pennsylvanica* from Woods Co., Oklahoma (BRIT, SMU), also have the aspect of *F. velutina* but similarly are far out of range for the latter.

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REVISION OF *VERBENA* SER. *TRICESIMAE* (VERBENACEAE)

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ABSTRACT

Twelve species of *Verbena* sect. *Verbena* series *Tricesimae* are treated: *V. calinfera*, *V. canescens* (type of the series), *V. falcata*, *V. gracilis*, *V. hirtella*, *V. johnstonii*, *V. livermorensis*, *V. moranii*, *V. perennis*, *V. pinetorum*, *V. subuligera*, and *V. xylopoda*. *Verbena neomexicana*, which has been considered central in this group, also is included in the treatment (for a total of 13 species) but in its strict sense may be more closely related to species of ser. *Verbena*. Four new species are described from northern Mexico and the adjacent USA: **V. livermorensis** Turner & Nesom, sp. nov. (Texas, Coahuila), **V. calinfera** Nesom, sp. nov. (Baja California), **V. moranii** Nesom, sp. nov. (Baja California), and **V. falcata** Nesom, sp. nov. (Nuevo León). Two new combinations are made: **V. hirtella** (Perry) Nesom, comb. nov. (Texas, Chihuahua, Coahuila), based on *V. neomexicana* var. *hirtella* Perry, and **V. xylopoda** (Perry) Nesom, comb. nov. (Arizona, New Mexico, Chihuahua, Sonora), based on *V. neomexicana* var. *xylopoda* Perry. *Verbena pinetorum* occurs primarily in Chihuahua and Sonora and is confirmed as a member of the Arizona flora. *Verbena neomexicana* Small (vs. *V. neomexicana* [A. Gray] Small) is the correct name for that species, which occurs mostly in southwestern New Mexico, extending to adjacent Arizona and Chihuahua. An overview of the group includes a key with descriptions and typifications. Photos (types) of the four new species are provided and a detailed distribution map is provided for each of the 13 species.
KEY WORDS: *Verbena neomexicana*, taxonomy, new species, Verbenaceae

Among the most significant taxonomic problems in North American *Verbena* are patterns of variation and nomenclature in *V. neomexicana* Small and taxa that been considered its close relatives. An adjustment in this group was made in the recognition of the Mexican *V. perennis* var. *johnstonii* Moldenke at specific rank (Nesom 1992). This species group is considered as a whole in the present study, which has been undertaken toward accuracy of the forthcoming FNANM treatment, since some of its members occur on both sides of the USA-Mexico border.

The group has often been informally referred to as the *Verbena neomexicana* group—it was described as sect. *Verbena* ser. *Tricesimae* Nesom (Nesom 2010a), with *V. canescens* Kunth as the type and including *V. neomexicana*. Remarkably, however, the present study indicates that strictly defined *V. neomexicana* may be more closely related to species of sect. *Verbena* ser. *Verbena* than to any of those treated here. Plants of ser. *Tricesimae* generally have glossy-surfaced leaves that usually are elongate and pinnatifid to deeply toothed (but varying to subentire) and that have impressed venation adaxially and revolute margins, slender, usually solitary or few-branched spikes with remote fruits, glandular rachises and calyces, distinctly exserted corolla tubes, and nutlets with commissural faces not reaching the apex. *Verbena neomexicana* has distinctly thinner leaflets and fruits with commissural faces that extend completely to the nutlet tips (see further comments under the species).

Perry (1933) recognized three varieties within *Verbena neomexicana*: var. *neomexicana* (typified by a collection from southwestern New Mexico and restricted in concept by her to only that area), var. *hirtella* Perry (the type from trans-Pecos Texas), and var. *xylopoda* Perry (the type from southern Arizona). Kearney and Peebles (1960) noted that *V. neomexicana* in Arizona is represented chiefly by var. *xylopoda*; they also recognized the occurrence of a similar species, *V. pinetorum*

Moldenke (the type from Chihuahua), in two southern counties. Shreve and Wiggins (1964) and Wiggins (1980) recognized both var. *xylopoda* and var. *hirtella* in the areas of their floristic coverage, but not *V. pinetorum*. All three varieties of *V. neomexicana* are included in recent accounts of the New Mexico flora (Martin & Hutchins 1980; Allred 2009).

O'Leary et al. (2010) have recognized two varieties within *Verbena neomexicana*, treating var. *xylopoda* as a synonym of the typical expression. They also treated the primarily south Texas endemic *V. runyonii* Moldenke (a distinct species of ser. *Plicatae* Nesom, fide Nesom 2010a and others) as a synonym of var. *hirtella* and *V. pinetorum* (a distinct species, as treated here) as a probable synonym of var. *neomexicana*. In their view, *V. russellii* Moldenke from Sinaloa, Mexico, also is a synonym of *V. neomexicana* but it is regarded by Nesom (2010b) as typical *V. officinalis*.

Verbena neomexicana was not unambiguously defined in Barber's phenetic study of the *Verbena stricta* complex (1982)—measurements were broadly variable and synonyms were not included, as she "adopted names and circumscriptions … to reflect the prevailing consensus." Annotations of specimens at SMU and TEX indicate that she considered the species to include var. *hirtella* and var. *xylopoda*. Citation of the Edwards Plateau of Texas in Barber's statement of overall geographic range of *V. neomexicana* was based on misidentifications of *V. canescens*, which was not a species among those in her study.

The majority of identifications of plants of the *Verbena neomexicana* group have placed them as one or another variety of *V. neomexicana*. With the accumulation of collections from northern states of Mexico, especially in the last thirty years, it has become possible to better discern patterns of variation among these plants—pointing to more discrete geographical patterns and the existence of more species than previously recognized.

Specimen citations are provided here for the four newly described *Verbena* species and, in clarification of their identities, for *V. hirtella*, *V. johnstonii*, *V. neomexicana* sensu stricto, *V. pinetorum*, *V. subuligera*, and *V. xylopoda*. Identifications of *V. canescens*, *V. gracilis*, and *V. perennis* have generally not been problematic and specimen citations are not included for these, except to document new or interesting distributions within the species.

KEY TO THE SPECIES

1. Proximal and midcauline leaves linear, usually unlobed, margins not toothed.

2. Stems eglandular, otherwise glabrous or glabrate to sparsely hispidulous, hispid-strigose, or hirsute-strigose ..... **Verbena perennis**

2. Stems sessile- to stipitate-glandular, otherwise sparsely but conspicuously hispid to hispidulous-scabrous or densely hispidulous-hirtellous.

1. Proximal and midcauline leaves pinnatifid or margins deeply toothed to regularly coarsely crenate to serrate.

3. Leaves not lobed or deeply toothed, margins regularly coarsely crenate to serrate.

4. California and Baja California. ..... **Verbena moranii**

4. Texas, Chihuahua, and Coahuila.

5. Stems sparsely hirsute-pilose, bristly-hirsute, or bristly-pilose, eglandular to very sparsely stipitate-glandular; leaves evenly distributed along the stems; corolla limbs 4–6 mm in diam. ..... **Verbena livermorensis**

5. Stems densely hirsutulous to hirtellous and minutely stipitate-glandular; leaves often clustered at base; corolla limbs (5–)6–9 mm in diam. ..... **Verbena hirtella**

3. Leaves pinnatifid to deeply toothed, sometimes 3-lobed

6. Stems prostrate to decumbent-ascending or ascending; midstem leaves mostly 0.5–1.5 cm long ..... **Verbena gracilis**

6. Stems erect to erect-ascending; midstem leaves mostly 2–5.5 cm long.

7. Floral bracts spreading at right angles, distinctly longer than the calyces ..... **Verbena subuligera**

7. Floral bracts ascending-erect, usually shorter or equalling the calyces.

8. Leaf teeth or lobes usually antrorsely angled, not recurved; New Mexico, Arizona, Chihuahua, Sonora.

9. Stems sparsely to moderately hirsute-villous to bristly-hirsute, eglandular; corolla limbs (5–)6–9 mm in diam. ..... **Verbena pinetorum**

9. Stems moderately hirsute to densely hispidulous, sparsely to very sparsely minutely stipitate-glandular, becoming densely stipitate-glandular distally into inflorescence; corolla limbs 3–5(–6) mm in diam.

10. Stems loosely hirsute; leaves evenly distributed, basal and lower cauline not persistent; spikes from medial to distal branches; corolla tubes 2.5–4 mm, limbs 1.5–2.5 mm in diam.; nutlets with commissural faces reaching tip **Verbena neomexicana**

10. Stems hispidulous to hirsutulous; leaves largest and often persistent basally and proximally; spikes from proximal to medial branches; corolla tubes 4–5 mm, limbs 4–7(–8) mm in diam.; nutlets with commissural faces not reaching tip ..... **Verbena xylopoda**

8. Leaf teeth or lobes spreading at nearly right angles and usually slightly recurved; Texas, Coahuila, Nuevo León, Zacatecas.

11. Leaves evenly distributed and relatively even-sized, surfaces conspicuously shiny, margins mostly non-revolute; stems eglandular to very sparsely stipitate-glandular ..... **Verbena falcata**

11. Leaves most basal and lower cauline, much reduced in size above, surfaces dull, margins strongly revolute; stems densely stipitate-glandular.

12. Leaves oblanceolate to elliptic-oblanceolate, oblong-oblanceolate, or narrowly oblanceolate in outline, midstem blades 2–7(–10, –15) mm wide, margins coarsely serrate to pinnately lobed with 1–5(–7) pairs of teeth or lobes ... **Verbena canescens**

12. Leaves mostly linear to linear-oblong, midstem blades 1–2 mm wide, proximal cauline with 1–2 pairs of linear lobes or unlobed and the margins entire ..... **Verbena johnstonii**

1. VERBENA CALINFERA Nesom, sp. nov. **Fig. 1, Map 1. TYPE: Mexico. Baja California.** El Pedregoso, 29° 32' N, 114° 33' W, occasional in disturbed soil at roadside, 730 m, 19 Apr 1975, *Moran 21749* (holotype: LL!; isotype: ARIZ!).

Verbenae hirtellae vestimento caulino et foliis non lobatis similis sed differt ramificatione inferiore, foliis latioribus regione petiolari distincta, floribus minoribus, lobis calycis triangularibus

patento-erectis, bracteis floralibus ovatis nonciliatis, et spicis fructificantibus relative compactis remanentibus.

Perennial herbs, short-lived, from a woody taproot and caudex. **Stems** erect to ascending-erect, 1–6 from the base, 20–35 cm, branching mostly in the proximal half, densely hirsutulous with short non-glandular hairs of uneven length, moderately stipitate-glandular. **Leaves** mostly obovate to subspatulate in outline, tapering slightly to a petiolar region, proximal and midstem 20–35 x 6–12 mm, basal mostly deciduous by flowering, cauline persistent, margins coarsely serrate with 1–4 teeth per side, sometimes slightly 3-lobed, veins slightly impressed adaxially. **Fruiting spikes** mostly solitary, from branches at midstem or lower, elongating but remaining relatively compact with fruits slightly overlapping or more open, 6–20(–25) cm; rachis with vestiture like cauline; floral bracts ovate-acuminate, 3–4.5 mm, usually as long as the calyx or slightly shorter, hirsute to hirsutulous, stipitate-glandular. **Calyces** 3.5–4 mm, hirsute and hirsutulous, stipitate-glandular, lobes triangular to narrowly triangular, erect to spreading-recurving, not connivent. **Corollas** light blue to deep blue, tubes 3.5–4.5 mm, 1–1.5 mm longer than the calyx, limbs 4–6 mm in diam. **Nutlets** 2–2.5 mm, commissural faces not reaching the apex, densely white-papillate or papillate distally and elongate-bullate proximally.

Additional collections examined. **Mexico**. **Baja California**. 3 mi W of San Agustin, wash bottom, 1900 ft, 17 Apr 1949, *Dressler 648* (MO); Cuesta de Jarahuái and vicinity, Laguna Seca, *Idria-Franseria* association with volcanic rock, 2400-3000 ft, 6 Apr 1950, *Gentry & Cech 8998* (ARIZ) and *9013* (ARIZ); 9 road mi SE of El Progresso, 29° 55' N, 115° 05' W, occasional on gravelly flat, 575 m, 25 Mar 1970, *Moran 16893* (ARIZ); S side of San Matías Pass, 31° 18.5' N, 116° 35' W, rocky N slope, scarce, 1050 m, 15 Sep 1977, *Moran 24805* (LL, plus 4 duplicates); Big Cañon of Tantillas Mts., 10 Sep 1875, *Palmer 312* (MO, NY; also F and GH, fide Perry, who IDed it as var. *xylopoda*); El Marmol [29°58' 0" N, 114°49' 0" W], locally abundant in disturbed soils and most depressions along main road and in washes, Apr 1967, *Stephenson s.n.* (MO); Laguna Seca, ca. 15 mi SE of Catavina (as measured along the road) on road to Laguna Chapala, rocky channel leading into a dry lake, ca. 2700 ft, 16 Oct 1959, *Thomas 8185* (ARIZ).

A collection of *Verbena calmfera* from the vicinity of El Marmol was alluded to by Shreve and Wiggins (1964) as the basis for the occurrence of *V. neomexicana* var. *hirtella* in Baja California. Similarly, Wiggins (1980) noted that var. *hirtella* in Baja California ranged from the Río Colorado delta south to the vicinity of El Marmol. *Verbena calmfera* is similar to *V. hirtella* in densely hirtellous stem vestiture and non-lobed leaves but different in its low branching, leaves broader in outline and with a distinct petiolar region, smaller flowers, triangular spreading-erect calyx lobes, broadly ovate floral bracts, and fruiting spikes that remain relatively compact. The two taxa are long-disjunct, with the closest points in their ranges separated by more than 400 miles.

2. VERBENA CANESCENS Kunth, Nov. Gen. Sp. (quarto ed.) 2: 274, plate 136. 1818. **Map 2**. **TYPE**: **Mexico**. **[Guanajuato]**. "Crescit in montibus Mexicanorum, prope Guanaxuato, Marsil et sodinam Belgrado," *Humboldt and Bonpland s.n.* (holotype: P fiche!).

Verbena roemeriana Scheele, Linnaea 21: 755. 1848. *Verbena canescens* var. *roemeriana* (Scheele) Perry, Ann. Missouri Bot. Gard. 20. 302. 1933. **NEOTYPE** (O'Leary et al. 2010, to be designated). The protologue cited **Texas**. [Comal Co.]: "Auf steinger Prairie bei Neubraunfels, [no date], *F. Römer s.n.*"

Verbena neei Moldenke, Phytologia 2: 241. 1947. Type: Argentina. De las Pampas de Buenos Ayres, [between 1789 and 1791], *L. Née iter 108* (holotype: MA, photo-NY!; isotype: NY! digital image!). O'Leary et al. (2010, fide Troncoso 1979) note that the type specimen of *Verbena neei* Moldenke from Argentina apparently represents *V. canescens* and probably is erroneously labeled. Moldenke (Phytologia 10: 98. 1964) recognized *V. neei* as a synonym of

V. canescens and at least it is clear that the plants are more similar to *V. canescens* than to any species known from South America.

Plants perennial (sometimes short-lived), taprooted. **Stems** branching from crown, (1–)3–10 from the base, erect to ascending-erect or decumbent-ascending, 15–35 cm, densely hirsutulous to hirsute-villous, minutely stipitate-glandular, less commonly sparsely stipitate-glandular to eglandular. **Leaves** mostly on proximal half of stems, persistent, oblanceolate to elliptic-oblanceolate, oblong-oblanceolate, or narrowly oblanceolate in outline, midstem blades 2–5(–6) cm x 2–7(–10, –15) mm, veins impressed adaxially, margins coarsely serrate to pinnately lobed with 1–5(–7) pairs of teeth or lobes, strongly revolute, hispid-hirsute and minutely stipitate-glandular; sessile to subpetiolate, distal commonly sessile and subclasping. **Spikes** 1 or 3(–5) from medial branches, elongate and loose or sometimes denser with overlapping fruits, 3–24 cm; floral bracts ovate-lanceolate, 4–8 mm, proximal longer than the calyces, sometimes slightly shorter. **Calyces** 2.1–3(–4) mm, hirtellous to hirsutulous, minutely stipitate-glandular, lobes deltate to narrowly lanceolate, erect, not connivent. **Corollas** blue to purple, tubes 2.5–4(–5) mm, 0.5–1(–1.5) longer than the calyces, limbs 2.5–4(–6) mm in diam. (not spreading). **Nutlets** 1.8–2 mm, easily separating; commissural faces ending below the nutlet tips, plates bullate to papillate, rarely smooth. $2n = 14$.

Flowering Mar–Jun(–Oct). Roadsides, disturbed sites, ledges, rocky and gravelly hills, flats, dry stream beds, mesquite scrub, acacia-leucophyllum scrub, spiny hackberry scrub, live oak woodland, oak-juniper woodland, limestone, calcareous soil, sand, caliche, sandy clay loam; 50–700 m; USA (New Mexico, Texas); Mexico (Aguascalientes, Coahuila, D.F., Durango, Guanajuato, Hidalgo, Mexico, Nayarit, Nuevo León, Oaxaca, Puebla, Querétaro, San Luis Potosí, Tamaulipas, Veracruz, Zacatecas).

Verbena canescens is identified from South America by O'Leary et al. (2010), who cite two SI collections from Colombia (Depto. Cundinamarca, in Feb and Mar of 1908). I have not seen these, but if the identifications are correct, it increases the plausibility that *V. neei* (see comments above) might actually have been collected in South America.

Some plants of *Verbena canescens* in eastern Coahuila, and some in Puebla, appear to have larger corollas than typical elsewhere over the range of the species (upper limits of variation in the description). They do not appear to be distinct in other features. See additional comments under *V. johnstonii*.

Verbena canescens has been attributed to Alabama, based on a report by Mohr (1901), who cited a collections from Mobile Co.: "Adventive from Mexico. … On ballast heaps." (US-"Herb. Geol. Survey"). Moldenke (1963) cited a collection from California (San Diego Co.: *E. Palmer 312*, NY) and from Nevada (Lincoln Co.: *M.E. Jones 554*, POM), but the species does not appear to be naturalized in either state.

The distribution of *Verbena canescens* reaches western outlyers in Culberson Co. and Reeves Co., Texas, but has not been documented for New Mexico, even though it seems likely to be in the southeastern corner of that state, perhaps in Chaves County. A record from San Miguel Co. cited by O'Leary et al. (2010) is based on a misidentification: *Hill & Levandoski12070* (NY!) instead is *Verbena plicata Greene*.

3. VERBENA FALCATA Nesom, **sp. nov. Fig. 2, Map 3. TYPE**: MEXICO. **TYPE**: **Mexico. Nuevo León**. Mpio. Galeana. Hwy to Potrero Prieto, wooded canyon, 1500 m, scattered plants, flrs blue, 11 Nov 2009, *Hinton et al. 28113* (holotype: MEXU; isotypes: HINTON-digital image!, TEX!, additional to be distributed).

Verbena pinetorum aspectu vestimento similis sed distinctus caulibus dense hirsutulis et foliis aequaliter distributis pinnatim dentatis divisionibus falcatis apicibus acutis, paginis conspicue nitidis, et marginibus plerumque non-revolutis.

Plants perennial herbs, thick-taprooted with caudex(?) becoming fibrous-rooted. **Stems** 1-several from the base, erect, 30–50 cm, densely hirsutulous, very sparsely stipitate-glandular to eglandular. **Leaves** evenly distributed along the stems, basal and lower cauline deciduous by flowering, ovate to lanceolate in outline, margins deeply toothed to pinnately lobed, the divisions spreading at nearly right angles and usually slightly recurved (falcate), midstem blades 2–5.5 cm x 6–20 mm, margins toothed with (2–)3–4 teeth or lobes per side, not revolute or only slightly so, veins impressed adaxially, hirsute-villous on both surfaces, eglandular to sparsely glandular, adaxial surfaces and epidermal coverings of abaxial veins conspicuously shiny; sessile or gradually attenuate basally to petiolar regions 3–10 mm. **Spikes** mostly solitary, 10–15 cm in fruit, elongate and loose; floral bracts triangular, shorter than the calyces. **Calyces** 2.5–3.5 mm, loosely hirsutulous, stipitate-glandular, lobes triangular, connivent. **Corollas** blue to pink, tubes 4–5.5 mm, 1.5–2 mm longer than the calyces, limbs 5–7 mm in diam. **Nutlets** 1.8–2 mm, easily separating at maturity, commissural faces not reaching nutlet apex, densely bullate.

Flowering Aug–Oct. Wooded canyons, bushy limestone hillsides, pine-oak with *Arctostaphylos*; 1250–1500 m; Mexico (Nuevo León).

Verbena falcata is distinctive in its densely hirsutulous stems and evenly distributed, pinnately toothed leaves with falcate divisions with acute apices, conspicuously shiny surfaces (hence the epithet), and mostly non-revolute margins. In its mostly solitary spikes, glandular calyces, and long-exserted corolla tubes, *V. falcata* is similar to others of the *V. neomexicana* group. Among these, it is generally similar in aspect to *V. pinetorum* of western Mexico, but the leaves of *V. falcata* are thicker and less dissected and the cauline vestiture is denser, shorter, and sparsely glandular to eglandular.

It is perhaps most likely that *Verbena falcata* is most closely related to *V. canescens*. *Verbena canescens* differs in its taller stems, leaves with revolute margins, dull surfaces, and shorter, more antrorsely directed teeth, the distal cauline leaves commonly sessile and subclasping, and in its corollas with shorter tubes and smaller limbs.

Additional collections examined. **Mexico. Nuevo León**. Mpio. Rayones, Galeana to Rayones +24 km, bushy limestone hillside, 1260 m, 17 Oct 1990, *Hinton et al. 20796* (TEX); 4 mi S of Galeana along Hwy 60, open pine forest, gypsum soil, 5370 ft, scattered along ravines, 5 Jul 1963, *McGregor et al. 98* (NY).

4. VERBENA GRACILIS Desf., Tabl. École Bot. ed. 3, 393. 1829. **Map 4**. **TYPE**: [probably **Mexico**]. Plant cultivated in the Botanical Garden of Paris (holotype: P, photo-MO!). O'Leary (2006) lectotypified *V. gracilis* Cham. (1836), a Brazilian species.

Verbena remota Benth., Pl. Hartw., 21. 1839. **TYPE. Mexico. Zacatecas** (fide K sheet) or **Aguascalientes** (fide GH and NY sheets), in arvis, 1839, *K.T. Hartweg 174* (holotype K; putative isotypes: GH, NY digital image!). "174. VERBENA (Euverbena) *remota*, sp. n., procumbens, pubescens, scaberrima, foliis inciso-pinnatifidus, laciniis cuneatis oblongisve subincisis acutiusculis, spicis terminalibus elongatis, floribus parvis remotis bractea lineari multo brevioribus."

Verbena artzonica A. Gray, Proc. Amer. Acad. Arts 19: 95. 1883. **TYPE: USA. Arizona**. [Cochise Co.]: Tanner's Canyon, near Fort Huachuca, 1882, *J.G. Lemmon 2858* (holotype: GH). Fide Perry (1933).

Plants perennial herbs, taprooted. **Stems** 1–3 from the base, often much-branched proximally, prostrate or ascending to decumbent-ascending or ascending-erect, 10–25 cm, hirsute with bristly hairs, minutely stipitate-glandular. **Leaves** ovate to ovate-lanceolate in outline, pinnately lobed or deeply toothed, basal and lower cauline persistent, midstem 5–15(–25) mm x 3–12 mm; petioles 1–3 mm. **Fruiting spikes** 1–3(–5) from proximal branches, fruits becoming remote proximally (lowermost sometimes axillary in uppermost cauline leaves) but usually remaining somewhat compact distally, 3–10(–15) cm; floral bracts linear-lanceolate to narrowly lanceolate, 3–5(–8 proximally) mm, longer than the calyces. **Calyces** 2–2.5 mm, hirsute and hispidulous, minutely stipitate-glandular at least near lobes, lobes deltate to deltate-apiculate, erect, not connivent. **Corollas** purplish to pink, tubes 3–3.5 mm, 0.5–1 mm longer than the calyx, limbs 2–2.5 mm in diam. **Nutlets** easily separating at maturity, 1.5–1.8 mm, commissural faces ending below the nutlet tips, bullate to low-papillate.

Flowering (Mar–)Apr–Sep. Rocky slopes, talus, canyon bottoms, grassy flats, road tracks; floodplains and terraces, lake edges, riparian woodlands, desert grassland, mesquite scrub, pine, pine-oak, oak, oak-juniper, oak-manzanita; 1000–1700(–2050 m; USA (Arizona, New Mexico, Texas); Mexico (Aguascalientes, Chihuahua, Distrito Federal, Durango, Guanajuato, Hidalgo, Jalisco, Mexico, Michoacan, Nayarit, Oaxaca, Puebla, Querétaro, San Luis Potosí, Sonora, Veracruz, Zacatecas).

Verbena gracilis is recognized by its low, branching habit, small and dissected leaves mostly on the proximal halves of the stems, long floral bracts, and small flowers and fruits. Like *V. canescens*, it has a wide distribution but its range lies mostly on the west side of *V. canescens* until they meet and become sympatric in southern Mexico. Stems of plants from central Mexico (including the type of *V. remota*) often are ascending-erect rather than prostrate to decumbent.

The only known record of *Verbena gracilis* from Texas is from Jeff Davis Co.: Davis Mts., Davis Mts. Resort, along Limpia Creek at Maguire Ranch ruins and resort HQ, 5700 ft, creek bottomland, 26 Jul 1986, *Worthington 14346* (NY). The collection is typical *V. gracilis*.

The record of *Verbena gracilis* for New Mexico is based on the report by McIntosh (1996), who documented the species from three localities in Hidalgo County (vouchers at NMC and SNM), and on the UNM collections cited here. The report by McIntosh of the species from Mora County, apparently far out of range, needs to be reexamined. **Hidalgo Co.**: Gray Ranch in the Animas Mts., 11 Aug 1990, *Ivey 21* (UNM); N end of Animas Mts, vicinity of Lower Indian Creek Canyon, rocky slopes, 5700 ft, 22 July 1975, *Wagner 1269* (UNM); Animas Valley, 4700 ft, 12 Sep 1975, *Wagner 1675* (UNM).

A putative record of *Verbena gracilis* from Utah is based on a citation by Perry (1933), who noted that "The specimen from Utah is atypical, but for practical purposes seems better referred here." [San Juan Co.]: Mesa E of Monticello, 25 Jul 1911, *Rydberg & Garrett 9201* (NY, as cited by Perry 1933). I was not able to find the specimen at NY and speculate that it has been reidentified as some other species. Utah is out of range for *V. gracilis* and the species has not been included in the Intermountain Flora (Cronquist 1984) or the Flora of Utah (Welsh et al. 2003), nor is it in the SEINet database or shown in the online Utah Atlas.

O'Leary et al. (2010) cite a collection of *Verbena gracilis* from Nuevo Leon, Mexico: Mpio. Derrumbadero, Cañon de los Capulines, above San Enrique, Hacienda San Jose de Raices, rare in meadows, 6 Aug 1935, *Mueller 2392* (MO, TEX). I annotated this as *V. gracilis* in 1992 but was mistaken then. The plants are single-stemmed and erect from the base, branching only about 5 cm above the base and the leaves have narrowly oblong midregions with triangular to lanceolate, slightly recurving lobes. They are similar in aspect to *V. falcata* but have long floral bracts much longer than

the calyces, which presumably influenced earlier identifications as *V. gracilis*. *Mueller 2392* is perhaps a hybrid but it clearly is not *V. gracilis*.

Records mapped for *Verbena gracilis* in Oaxaca are the following: Las Sedas, dry calcareous hills, 6000 ft, 11 Aug 1894, *Pringle 4784* (NY); near Mitla, Jun 1888, *Seler 22* (GH, as cited by Perry 1933); Las Sedas, Sep 1894, *Smith 221* (NY). The Smith collection is neary typical *V. gracilis*, but the Pringle collection has deeply toothed leaves and hirtellous stems suggesting genetic influence from *V. canescens*. Plants of both have prostrate stems radiating from the taproot.

5. VERBENA HIRTELLA (Perry) Nesom, **comb. et stat. nov. Map 5**. *Verbena neomexicana* var. *hirtella* Perry, Ann. Missouri Bot. Gard. 20: 298. 1933. **TYPE: USA. Texas**. Brewster Co.: dry arroyas and foothills of the Chisos Mts., 22 May 1928, *E.J. Palmer 34065* (holotype: MO!, digital image!; isotypes: GH-2 sheets, MO!, MO-digital image!, NY!, NY-digital image!).

Plants perennial, taprooted. **Stems** 2–8 from the base, erect, 15–60 cm, densely hirsutulous to hirtellous and minutely stipitate-glandular. **Leaves** often clustered at base, basal and lower cauline persistent, narrowly oblanceolate to oblanceolate or narrowly obovate, cauline similar to basal, blades 2–4 cm (basal) to 1.5–3 cm (midstem) x 6–10 cm, veins impressed adaxially, margins coarsely crenate to serrate with (2–)4–8 pairs of teeth, weakly revolute, densely hirsutulous to hirtellous and minutely stipitate-glandular; basally attenuate to subpetiolate. **Spikes** 1 or 2–3 from branches at midstem or below, elongate and slender, 8–15(–25) cm; floral bracts ovate-acuminate to ovate-lanceolate, 3–4 mm, shorter than the calyces. **Calyces** 3.5–4.5(–5) mm, densely hirsutulous to hirtellous and minutely stipitate-glandular, lobes deltate to triangular, erect, not connivent. **Corollas** blue to purple or lavender, tubes (3.5–)4.5–5.5 mm, 1–1.5(–2) mm longer than the calyx, limbs (5–)6–9 mm in diam. **Nutlets** 2–2.5 mm; commissural faces ending below the nutlet tips, with bullate plates. $2n = 14$.

Flowering Mar–Jun(–Nov). Rocky slopes, limestone flats, stream beds, sandy washes, roadsides, disturbed sites, grassy hills, riparian brush and woodland, *Acacia-Ungnadia-Celtis-Opuntia* scrub, mesquite brushland, sotol-agave, creosote bush; 1000–1800 m; N.Mex., Tex.; Mexico (Chihuahua, Coahuila).

The collections of *Verbena hirtella* from New Mexico appear to be disjunct from the larger range but the plants appears to be typical for the species. Localities in Val Verde Co., Texas, Durango, southern Coahuila, and Zacatecas appear to be outliers.

Verbena hirtella is morphologically and geographically discontinuous from *V. neomexicana*. They differ in vestiture, leaf morphology, corolla size, and nutlet morphology. *Verbena xylopoda* is more similar to *V. hirtella* in vestiture but these two are distinct by the contrasts below. I have seen no intermediates between *V. xylopoda* and *V. hirtella* in west-central Chihuahua, where they are sympatric.

1. Stems densely hirsutulous to hirtellous and stipitate-glandular; leaves unlobed, (basal and cauline) coarsely crenate to serrate with (2–)4–8 pairs of teeth; corolla limbs (5–)6–9 mm in diam. ..... **Verbena hirtella**

1. Stems moderately hirsute to densely hispidulous, sparsely to very sparsely stipitate-glandular; leaves (basal) crenate-serrate or coarsely toothed to deeply pinnately toothed or pinnatifid, cauline pinnatifid with (1–)2–3(–4) teeth or lobes per side, sometimes 3-lobed; corolla limbs 4–7(–8) mm in diam. ..... **Verbena xylopoda**

Additional specimens examined. **USA**. **New Mexico**. Sierra Co.: Elephant Butte Dam, open hillside, 3800 ft, 30 Apr 1933, *Nelson 2107* (UNM). **Socorro Co.**: hills just W of Socorro, along arroyo, 16 May 1953, *Castetter 5164* (UNM); 6 air mi W of Socorro on W side of Strawberry Peak, 6400 ft, rocky hillside with *Gutierrezia*, *Rhus*, *Atriplex*, *Opuntia*, *Yucca*, *Juniperus*, 26 Jul 1977, *Edwards & Repass 4730* (NY); rocky knoll in vicinity of Willow Springs just outside the SW corner of Bosque del Apache Refuge, 10 May 1949, *Fleetwood s.n.* (UNM); Sevilleta, road to the microwave tower, 7.35 mi from the north gate, S slope, 19 Apr 1989, *Maddux & Loftin 32* (UNM); low mountains W of San Antonio, 14 Apr 1908, *Wooton 3852* (UNM). **Texas**. **Brewster Co.**: under cattle guard, ca. 2 mi. N of Tres Papalotes in the Solitario, on the Big Bend Ranch, 2 Jun 1975, *Butterwick & Strong 600* (TEX); vicinity of Tres Papalotes in the Solitario, on the Big Bend Ranch, 2 Jun 1975, *Butterwick & Strong 609* (TEX); ca. 1 mi. NW of Prospect Mt. and just E of Presidio/ Brewster County line, in the Solitario on the Big Bend Ranch, just E of stocktank, 5 Jun 1975, *Butterwick & Strong 724* (TEX); S side of Burro Mesa. Big Bend National Park, talus slope, drainage area, 23 Sep 1966, *Correll 33855* (LL); down the road from headquarters of the Blackgap Wildlife Management Area, 3 Jun 1969, *Grimes 309* (SMU); dry creek crossing on Terlingua-Chisos Mts road, just N of Chisos Mts, 3000 ft, 22 Aug 1947, *Hinckley 4004* (NY); ca. 10 mi. S of Marathon on road to Big Bend Park, roadside, 4000 ft, 20 Oct 1948, *Hinckley 4614* (NY, TEX); near Shafter, 10 Apr 1929, *Ingram 96342* (UNM); campground area, Inner Basin, Big Bend Natl Park, oak-pinyon-juniper, 2 Aug 1959, *Kruckeberg 4796* (NY); Big Bend Natl. Park, 13.8 mi E of the west entrance, 16 Apr 1960, *Lewis & Oliver 5457*, voucher for $n = 7$ (MO); Black Gap Wildlife Refuge, near entrance to Headquarters from Hwy 2627, rocky slope, sotol and agave abundant, 9 Jun 1969, *Mahler 13* (SMU); Chisos Mts., 1 Sep 1937, *Marsh 249* (TEX); Chisos Mts., gravelly mesa N of mts., 1065 m, 27 Jun 1931, *Moore & Steyermark 3277* (MO, NY); Chisos Mts., 1 Aug 1931, *Mueller 8138* (MO); Chisos Mts., 25 Aug 1931, *Mueller 8139* (MO, NY, TEX); Big Bend National Park, 3.5 km S of Panther Jct on Rio Grande Village Drive, gravelly roadside, 17 Mar 1986, *Reuter 287* (BRIT); Big Bend National Park, "Desert Tank", 7 mi. S of Cross Roads leading CCC Camp-Marathon-Hot Springs, 17 Jun 1941, *Rose-Innes & Moon 1200* (TEX); ca. 35 mi S of Black Gap Wildlife Management Area, SE of Marathon, limestone rocks of Brushy Canyon, Chihuahuan Desert vegetation, 20 Jun 1968, *Rowell 11635* (SMU, UNM); Oak Spring run-off area, dry stream bed, 3600 ft, 23 Aug 1970, *Semple 357* (MO); Big Bend National Park, Hannold Draw, mesquite brushland, frequent about disturbed places, 3039 ft, 8 Nov 2002, *Sput & Marin 15080* (BRIT); Alpine, rocky hillside, 4600 ft, Apr 1932, *Steiger 1373* (NY); Chisos Mts., Wilson Ranch, 19 Jun 1931, *Tharp s.n.* (NY, TEX-2 sheets); Chisos Mountains foothills, 19 Jun 1931, *Tharp s.n.* (SMU); 71 mi. S of Alpine, calcareous soils, 3 Aug 1999, *Turner 99-10* (TEX); 0.2 miles along 2627 from hiway 385 (Big Bend ark road), limestone soils along roadside, 29 Sep 2003, *Turner & Dodson 23-285* (TEX); old lake bed at entrance of Big Bend State Park, 3 May 1937, *Warnock s.n.* (NY, TEX); Big Bend Park, 12 mi N of Hot Springs, along small sandy draw on alluvial fan, 20 Mar 1941, *Warnock 537* (NY, TEX); Buena Vista ca. 6 mi W of Alpine, 3 Apr 1937, *Warnock W168* (NY); Nichols Ranch, infrequent about level lands, 8 Aug 1937, *Warnock 20436* (TEX); Big Bend National Park, Terrapin Tank, near Lone Mt., 4000 ft, frequent on limestone flat, 2 Sep 1947, *Warnock & Hinckley 7040* (TEX); 7.1 mi by Hwy 118 N of the jct with Hwy 170 at Study Butte, roadside, creosote bush community, ca 3000 ft, 3 Apr 1983, *Worthington 9718* (NY, SMU); Chisos Mts., Nail Place, 12 Aug 1915, *Young 112* (MO, TEX). **Hudspeth Co.**: no locality data, 30 Jul 1943, *Tharp 43-804* (MO); ca. 7 mi WSW of Hot Wells, north peaks of Eagle Mts., sandstone mountainside leading up to conglomerate cliffs, 17 Jul 1943, *Waterfall 5143* (MO, NY). **Jeff Davis Co.**: Davis Mts., scenic drive S from Kent to HO Canyon, 22 Aug, 1949, *Tharp & Jansen 49-1144* (NY, TEX); 11 mi. N of Alpine, sparse along highway. igneous soil, 4550 ft, 18 Aug 1949, *Warnock 8885* (TEX). **Presidio Co.**: ca. 500–1000 ft NE of houses along road leading N from houses, at GPS point ± 17.3 ft., ca. 6 mi NW of jct US 90 and RM 2810 at Marfa, Hip-O Ranch Preserve, Marfa Quadrangle, occasional in impacted pasture area on fine textured tight soils in bottom of broad shallow draw between rocky igneous slopes, 4960 ft, 25Apr 2001, *Carr 19623* (TEX); N sides of E-W road parallel to and just N of RR track, 0.7

roadmiles E of main N-S road on Hip-O Ranch Preserve (TNC), just W of another ranch road (marked on topo) leading N, occasional in igneous-gravelly soil on S-facing gentle slope on low hill in grassy basin, 4830–4890 ft, 24 Aug 2001, *Carr 19955* (TEX); NW-facing rocky igneous slope and flat bench at top of slope, ca. 1–50 ft. above flat along E side of Big Trestle Draw, Hip-O Ranch Preserve (TNC), occasional in *Bouteloua curtipendula-B. gracilis* grassland dotted with *Rhus microphylla*, on NW-facing rocky igneous slope and flat bench at top of slope, 4930–4980 ft, 29 Aug 2001, *Carr 20014* (TEX); 16 mi. S of Marfa along roadside, gravel knoll; 19 Apr 1961, *Correll & Rollins 23652* (LL, NY, SMU); 18 mi N of Presidio on US 67, creosote bush, 2 Apr 1969, *Dunn 16070* (MO, NY); Marfa, 4 May 1932, *Garner 50* (TEX); ca. 38 mi SW of Marfa along Hwy 2819, middle portion of Pinto Canyon, 14 Apr 2004, *Gray & Turner 24-107* (TEX); Ruidosa, common, mountain sides, 13 Apr 1919, *Hanson 645* (NY); just E of Presidio, larrea-mesquite, limestone soil, 27 Mar 1972, *Higgins 5070* (NY); Marfa, Apr 1938, *Hinckley 1089* (ARIZ, NY, TEX-2 sheets); Marfa-Ruidosa road ca. 3 mi SW of Marfa, rocky hill, 4900 ft, 15 Aug 1940, *Hinckley 1254* (NY-2 sheets); slope E of Vieja Pass, 5100 ft, 16 Jul 1941, *Hinckley 1971* (NY, TEX); creek bank ca. ½ mi W of old Madrid (Madril) ranch north branch Arroyo Primero, ca. 3300 ft, 28 Mar 1942, *Hinckley 2428* (NY); Sierra Tierra Vieja, Clyde MacFarland ranch house, 4500 ft, 9 Jun 1943, *Hinckley 2709* (NY); near old Ross Mine, 22 Aug 1944, *Hinckley 3218* (NY); Capote Peak , 30 Aug 1944, *Hinckley 3246* (NY); along Oso Creek on the N side of the Chinati Mts. at Old Woods Ranch, 18 mi. NW of Shafter, 10 Nov 1946, *Hinckley & Warnock 46942* (NY, TEX); 0.5 mi SW of Solitario Peak, igneous hill, 4500 ft, 12 Oct 1958, *Johnston 3452* (TEX); Chinati Mtns. Natural Area. Pelillos Arroyo, a major drainage on the SW side of the Chinati Mtns., igneous boulders and alluvium at edge of arroyo. S-facing bank of arroyo, 3705 ft, Chihuahuan Desert scrub with *Acacia greggii*, *Yucca torreyi*, *Opuntia imbricata*, *Tecoma stans*, *Brickellia*, and *Guaiacum*, 21 Apr 2004, *Lott & Rankin 4952* (TEX); Chinati Mtns. State Natural Area, Pelillos Canyon, above the dam, riparian area with *Juglans*, *Salix* spp., *Cephalanthus*, *Tecoma*, *Fraxinus*, and *Quercus grisea*, in shade of boulders along streambed, 3840 ft, 22 Apr 2004, *Lott & Rankin 4989* (TEX); Chinati Mtns. State Natural Area, Cinco de Mayo Canyon, parallel and to W of San Antonio Canyon, slopes of wide canyon trending N-S, with *Viguiera stenoloba*, *Tecoma stans*, *Opuntia imbricata*, *O. engelmannii*, *Celtis pallida*, *Mimosa*, *Acacia greggii*, *Justica*, and *Heteropogon*, in large gravel-small boulders of old roadbed, 4133 ft, 6 Aug 2004, *Lott et al. 5163* (TEX-2 sheets); Chinati Mtns. State Natural Area. Pelillos Canyon, between the dam and Tinaja Prieta fork, canyon bottom woodland of *Salix*, *Juglans*, *Cephalanthus*, and *Quercus*, rare in gravel of canyon bottom, 3910 ft, 25 Mar 2005, *Lott et al. 5447* (TEX); Chinati Mtns State Natural Area, NE-SW trending tributary to San Antonio Canyon, below old San Antonio Mine, canyon scrub of *Acacia greggii*, *Ugnadia*, *Chilopsis*, *Celtis pallida*, *Opuntia imbricata*, and *Menodora*, 4370 ft, 21 Aug 2005, *Lott et al. 5569* (TEX); 28 mi. S of Marfa, off Hwy 67, rolling grasslands, 6 Aug 1945, *Lundell & Lundell 14340* (LL, NY, SMU); off Hwy 67, 6 mi N of Shafter, outlying hills of the Chinati Mts., [no date], *J.R. Lundell 5* (LL); 9 mi N of Shafter, 6 Jun 1977, *Van Devender s.n.* (ARIZ); Livingston Hills, 4 mi S of Shafter, limestone, 4200-4300 ft, 21 Apr 1975, *Van Devender s.n.* (ARIZ); Tierra Vieja Mts, Vieja Pass, SW of Valentine, limestone soil, 4200 ft, 7 Aug 1949, *Warnock 8908* (LL, SMU); along highway, 25 mi SW of Marfa toward Shafter, 4000 ft, 31 Feb 1957, *Warnock 14337* (LL); Bunton Flats, highway ca. 35 mi S of Marfa, frequent on limestone soil, 4500 ft, 27 Oct 1946, *Warnock 46615* (MO, NY, TEX); Bogel Ranch, 3 mi W of San Estaban Lake, grassland, sandy soil, 4100 ft, 28 May 1957, *Warnock & McBryde 14555* (LL). **Valverde Co.**: Del Rio, 950 ft, 19 Aug 1932, *Fisher s.n.* (NY). **MEXICO. Chihuahua**. Mpio. Chihuahua: 6 mi S of Cd. Chihuahua, roadside, 25 Jul 1967, *Alison & Moldenke 2105* (LL); microwave relay station, 21 km NW of Escalon, E of hwy to Jimenez, 26 57 N 104 35 W, 1650 m, rather steep hills of extrusive igneous rocks, *Larrea*, *Parthenium*, *Fouquieria*, *Lippia*, *Jatropha*, 7 Jul 1972, *Chiang et al. 8311A* (LL); 12 mi E of Parral, Rte 45, gravelly brush-covered plain, 6 May 1959, *Correll & Johnston 21528* (LL); 6 mi SE of Sacramento, Hwy 45, rocky open hilltop, 10 May 1959, *Correll & Johnston 21737* (LL, MO): Santo Domingo, mine, 3000 ft, 25 Jun 1977, *Dwyer 14189* (MO, NY); 18 mi N of Chihuahua City, 3 Aug 1965, *Flyr 507* (SMU); 15 mi NW of Escalon on Hwy

49, 30 mi S of Cd. Jimenez, roadside, open Chihuahuan desert with *Larrea*, *Acacia*, *Flourensia*, *Buddleia*, *Opuntia*, *Jatropha* and numerous annuals, 4500 ft, 24 Aug 1971, *Henrickson 5944* (LL); 39 rd mi NE of Aldama along Hwy 16 in limestone outcropping in open Chihuahuan desert, locally common on flats, to 1 ft high, with *Larrea*, *Flourensia*, *Fouquieria*, *Nama*, and grasses-annuals, etc, 4800 ft, 15 Sep 1972, *Henrickson 7617* (LL); Mpio. Chihuahua, 26 km S de Chihuahua, veg. Baja, desértica, 1600 m, 20-40 cm high, 6 Aug 1982, *Hernandez 8458* (TEX); Estacion Microondas "La Colorado" ca 38 km S of Jimenez on hwy to Torreon, 26 57 N 104 35 W, *Acacia-Bouteloua*, 31 Mar 1973, *Johnston et al. 10524* (LL); canyon in N face of Sierra Rica, S of Rancho La Consolacion, 1400-2000 m, steep slopes of igneous rocks, matorral, *Quercus*, *Ptelea*, *Garrya*, *Juglans*, *Sageretia*, 3 May 1973, *Johnston et al. 10773B* (LL); 8 mi W of Chihuahua, 5 Oct 1958, *Jones 23227* (TEX-2 sheets); Chihuahua, 3-4 Sep 1935, *LeSueur 53* (TEX), 16 Aug 1935, *LeSueur 231* (TEX); Rancho Experimental La Campana, carr. Chihuahua-Cd. Juarez, 1500 m, pastizal, Sep 1958, *Martinez M. 110* (TEX); N of Ricardo Flores Magón, 0.8 mi N of jct Hwy 10 on Hwy 195, at sharp bend in road, gravelly somewhat sandy colluvium, 1800 m, 28 Aug 1989, *Mayfield 77* (LL); 4.6 mi NE of Buenaventura, near KM 100, roadside with cholla, 5600 ft, 28 Aug 1967, *Oliver et al. 517* (MO); roadside wash at jct of Hwy 16 and road to Placer de Guadalupe, 7 Apr 1971, *Powell et al. 2063* (TEX); 11 mi NE of Lake Granero turnoff, Hwy 16, limestone rocky soil, 7 Apr 1973, *Powell et al. 2479* (LL); rocky hills near Chihuahua, 16 Apr 1885, *Pringle 270* (NY-3 sheets); Santa Eulalia Mts., 6225 ft, 19 Aug 1939, *Shreve 9097* (ARIZ); gravelly knolls along Chih Hwy 16, 35 mi S of Coyame, ocotillo, creosote bush, yucca, 24 Mar 1975, *Spellenberg 3984* (NY); 20 mi S of Chihuahua, calcareous desert, 9 Aug 1961, *Waterfall 16100* (SMU); 3 mi N of Cd. Juarez, road to Cd. Camargo, ca. 4500 ft, 1 Aug 1939, *White 2168* (ARIZ); N fork of the "Temporal" canyon, Benigno Mora Rancho, E slope of the Sierra de la Brena, ca 10 km W of Est. Mata Ortiz, 1900–2300 m, small creek canyon, *Quercus* spp, *Pinus* spp., *Pseudotsuga*, 29 Jul 1972, *Wilson & Johnston 8483* (LL); between Sacramento and Chihuahua, 24 Aug 1846, *Wislizenus 150* (MO); near San Pablo, 29 Apr 1847, *Wislizenus? 545* (MO); 5 km N Cd. Chihuahua, matorral, 6 Jun 1994, *Yen & Estrada 2616* (BRIT); 12 km N of Cd. Chihuahua, carretera libre Chihuahua-Juarez, *Mimosa aculeatocarpa*, 18 Aug 1996, *Yen & Estrada 5466* (BRIT); Mpio. Aldama, 3 km S Cd. Aldama, matorral y mezquital, 1450 m, 31 Aug 1996, *Yen & Estrada 5811* (BRIT); Mpio. Camargo, Rancho Mestenas, 20 km S de La Perla, matorral *Acacia-Mimosa*, pastizal *Bouteloua*, 1450 m, 20 Oct 1996, *Yen & Estrada 6740* (TEX); alrededores de Chihuahua, asociaciones de *Mimosa-Acacia*, 1490 m, 9 Mar 1997, *Yen & Estrada 6907* (BRIT); alrededores del poblado La Perla, 1490 m, matorral *Acacia-Larrea-Mimosa-Prosopis*, 21 May 1997, *Yen & Estrada 7128* (TEX); Mpio. Manuel Benavides, 5.6 km brecha Ojinaga-Manuel Benavides, *Larrea-Flourensia-Acacia*, 1250 m, 25 Jul 1997, *Yen & Estrada 7429* (BRIT); 26 km N de Chihuahua, carr. Chihuahua-Juarez, 1510 m, matorral *Acacia-Aloysia*, 27 Sep 1997, *Yen & Estrada 8805* (BRIT). **Coahuila**. Ca. 23 air mi NW of Las Delicias, in a valley of Sierra de las Delicias near old mine, rocky limestone NE-facing slopes, with *Acacia*, *Agave*, *Jatropha*, *Parthenium*, *Leucophyllum*, *Viguiera*, etc., 4800 ft, 29 Aug 1971, *Henrickson 6132* (TEX); 3 mi N of Castillon, desert, 1940, *Johnston & Muller 193* (LL); between San Rafael and San Vicente, via road over the northern foothills of the Sierra de las Cruces, about bushes, 8 Sep 1940, *Johnston & Muller 1057* (LL); mountain valley 24 km NW of Fraile, with much bare limestone, partially covered with *Agave* and *Yucca*, 2350 m, 25 03N 101 18 W, 16 Jul 1941, *Stanford et al. 426* (NY); 4 km N of Santa Elena, dry hillside, 10-15 cm tall, vicinity of Santa Elena Mines, calcareous E foothills of the Sierra de las Cruces, 9 Jun 1941, *Stewart 402* (LL); Sierra del Carmen, Canyon de Sentenela on Hacienda Piedra Blanca, moist stream side, 6 Jul 1936, *Wynd & Mueller 525* (ARIZ). **Durango**. Mpio. Mapimi, top of Puerto de la Cadena, the pass through the Sierra de la Cadena, 28 km W of Mapimi on Hwy 30, limestone slopes and gullies with desert scrub of *Yucca*, *Opuntia*, *Fouquieria*, *Flourensia*, *Acacia*, *Agave*, etc, 5000 ft, 2 Jul 1986, *Sanders et al. 6650* (TEX). **Zacatecas**. Ojo de Agua, near Sombrerete, ca. 6500 ft, 5 Aug 1960, *Hevly et al. s.n.* (ARIZ).

6. **VERBENA JOHNSTONII** (Moldenke) Nesom, Phytologia 73: 321. 1992. **Map 6**. *Verbena perennis* var. *johnstonii* Moldenke, Phytologia 2: 150. 1946. *Verbena perennis* forma *johnstonii* Moldenke, Phytologia 44: 329. 1979. **TYPE**: **Mexico**. **Tamaulipas**. Mpio. Miquihuana. 12 km NW of Palmillas on the road to Miquihuana, in broad, damp river beds, varied vegetation of large shrubs, small trees and herbs, flowers blue, 1950 m, 14 Aug 1941, *L.R. Stanford, K.L. Retherford, and R.D. Northcraft 915* (holotype NY!, digital image!; isotype: MO!, digital image!).

Plants perennial, taprooted. **Stems** erect, commonly 5–10 arising from the root crown, 30–50 cm, densely hispidulous-hirtellous, minutely stipitate-glandular. **Leaves** mostly linear to linear-oblong, basal and lower cauline persistent, midstem blades 3–5 cm x 1–2 mm, midvein impressed adaxially, margins entire or sometimes the proximal with 1–2 pairs of linear, widely divergent to falcate-recurved lobes 5–10 mm long, narrowly but strongly revolute, densely hirtellous, minutely stipitate-glandular; sessile, not clasping. **Fruiting spikes** solitary, elongate and slender, 10–25 cm; floral bracts narrowly ovate-lanceolate, 3–4(–5) mm, shorter than or barely equalling the calyces. **Calyces** 3.5–4(–5) mm, densely hirtellous, minutely stipitate-glandular, lobes linear-lanceolate, not connivent. **Corollas** purple to blue with a white throat, tubes 4–5 mm, limbs 6–7 mm in diam. **Nutlets** 2–2.8 mm, commissural faces ending below the nutlet tips, with plates bullate or at least the upper plates low-papillate. 2n = unknown.

Flowering Mar–Oct. Matorral, juniper woodland, pine-oak woodlands; (750–)1800–2400 m; Mexico (Coahuila, Nuevo León, Tamaulipas, Zacatecas).

O'Leary et al. (2010) have returned *Verbena johnstonii* to its original taxonomic position as a variety of *V. perennis*, based on the similarity of the two taxa in linear to sublinear leaves, with the comment (p. 100) that "siendo la pubescencia lo unico que las diferencia, lo cual no es lo suficiente para sostener una especie." Leaf shape, however, was not the only difference noted in the elevation of *V. johnstonii* to specific rank (Nesom 1992).

Verbena johnstonii and *V. perennis* are allopatric and non-intergrading. In addition to the completely discontinous difference in vestiture (O'Leary et al. noted that the vestiture of *V. johnstonii* is similar to that of *V. canescens*), Nesom (1992) also pointed out that *V. johnstonii* has white-throated corollas and papillate commissural faces, while *V. perennis* has blue to purple corolla throats and consistently bullate, non-papillate commissural faces. In *V. johnstonii*, the midstem blades are 30–50 mm long, while in *V. perennis*, they are (5–)10–25 mm long; and if lobes are present, they are differently shaped. There would never be an issue in identifying a plant as one or the other species.

Several collections mapped earlier as *Verbena johnstonii* (Nesom 1992) are here treated as narrow-leaved variants of *V. canescens*: **Coahuila**. Sierra la Gavia, *Johnston et al. 10284D* (LL); N side of Sierra Paila, *Johnston et al. 11687* (MO); Sierra de San Lazaro, *Muller 3045* (LL). **Nuevo León**. Cañon de Potrerillos, *Johnston et al. 10235B* (LL). These might be construed as hybrids, but they are from north of the range of typical *V. johnstonii*. In any case, the close similarity between *V. johnstonii* and *V. canescens* suggests that they may be sister species.

Additional collections examined. **Mexico**. **Coahuila**. Mpio. Parras. Parras–>Tanque Menchaca, S slope of Sierra de Parras, roadside shale hillside, 1980 m, 9 Nov 1999, *Hinton et al. 27464* (HINTON-digital image!); ca. 6 km airline W of Saltillo, E extremity of the Sierra de la Vega, 3 Mar 1973, *Johnston et al. 10500C* (LL); Mpio. Castanos, Puerto de San Lazaro, Sierra de San Lazaro, 30 Aug 1939, *Muller 3045* (LL); Mpio. Parras, Sierra de Parras, ca. 11 air mi S of Parras on road toward Menchaca, S- and W-facing slopes in limestone and shale, veg. of *Dasylirion*, *Yucca*, *Ocotillo*, *Rhus*, *Gochnatia*, *Leucophyllum*, *Viguiera*, ca. 1980–2000 m, 19 Sep 1993, *Nesom 7642* (MO, TEX); Sierra de Parras, Mar [year?], *Purpus 1094* (MO, NY); 9 km S of Parras on Sierras

Negras, 3 Jul 1941, *Stanford et al. 198* (MO), *Stanford et al. 234* (MO, NY); valley 15 km W of Concepción del Oro, just within Coahuila border, valley floor sparsely covered with *Yucca* and *Larrea*, 2300 m, 19 Jul 1941, *Stanford et al. 486* (MO, NY); Ojo Caliente, limestone slope S of town, 16 Aug 1979, *Wagner et al. 4132* (MO); 10 mi N of Saltillo, limestone hillside, 25 Aug 1961, *Waterfall 16623* (SMU). **Nuevo León**. Mpio. Galeana, 5.3 km E of El Potosí on road to Cerro Potosí, 22 Apr 1984, *Cowan 4636* (ANSM, MEXU, MO, TEX, UAT); 5 km S of Puerto México, KM 812, carretera México-Saltillo, 18 May 1965, *Hernández s.n.* (LL); above Santa Rita, 14 May 1981, *Hinton et al. 18241* (MO, TEX); W slope Potosí, 29 Jun 1983, *Hinton et al. 18487* (TEX); above San Ubert, 20 Mar 1992, *Hinton et al. 21853* (NY, TEX); Mpio. Galeana, San Roberto to Y, gypsum hillside, 2015 m, 5 Sep 1995, *Hinton 25501* (TEX); Mpio. Aramberri, near San Francisco, 1765 m, gypsum hillside, 1 Jun 1997, *Hinton 27065* (TEX); Mpio. Galeana, SW of Laguna de Labradores, arid gypsum hillside, 2264 m, 17 Oct 2003, *Hinton 28025* (TEX); foothills below Pablillo, 15 mi SW of Galeana, 21 May 1934, *Muller 506* (TEX); Mpio. Derrumbadero, Cañon de los Capulines, above San Enrique, Hacienda San José de Raices, 6 Aug 1935, *Mueller 2375* (MO, TEX); Mpio. Galeana, ca. 38 km ENE of Dr. Arroyo, NNW side of Cerro Peña Nevada, road crossing of exposed gypsum area, 2130 m, 1 Aug 1983, *Nesom 4778* (TEX); 5.6 mi S of jct Hwy 61 and Linares-San Roberto road, 26 Oct 1981, *Poole 2494* (TEX); ca. 15 mi E of San Rafael off Hwy 57, 22 Jul 1977, *Wells & Nesom 91* (LL). **Tamaulipas**. The type collection. **Zacatecas**. Ca. 3.5 air mi W of Concepción del Oro on rock-paved road to Mazapil in mountains, 0.5 mi W (below) the crest of the range in woodlands of *Pinus johannis* with *Yucca carnerosana*, *Lindleya*, *Nolina*, *Eupatorium*, *Stevia*, etc., 2200 m, 27 Jun 2001, *Henrickson 22692* (TEX); Puerto de Rocamontes at the Zacatecas-Coahuila state line, 29 Mar 1973, *Johnston et al. 10489* (LL); 10.5 mi from Concepción del Oro toward Mazapil, 24 Aug 1977, *Lehto 21751* (LL); 15 km W of Concepción del Oro, 20 Jul 1941, *Stanford et al. 507* (MO).

7. **VERBENA LIVERMORENSIS** Turner & Nesom, **sp. nov**. **Fig. 3, Map 7**. **TYPE**: **USA. Texas**. Jeff Davis Co.: Davis Mtns., on gravel and sand bars of creeks, 11 Jun 1926, *E.J. Palmer 30791* (holotype: TEX!; isotypes: MO!, TEX!).

Verbenae hirtellae similis in ubique aspectu et distributiem sympatriam habens sed differt distributio geographic restrictiori et caulibus setoso-villosis plerumque eglandulosis.

Plants perennials, taprooted. **Stems** 1–3 from the base, often much-banched proximally, erect to ascending-erect, 35–65 cm, sparsely hirsute-pilose, bristly-hirsute, or bristly-pilose, eglandular to very sparsely stipitate-glandular. **Leaves** evenly distributed along the stems, basal and lower cauline deciduous by flowering, narrowly oblanceolate to oblong-oblanceolate, midstem 1.5–5 cm x 3–8(–12) mm, margins coarsely serrate with (2–)3–8 antrorse teeth per side, rarely somewhat 3-lobed, narrowly revolute, veins impressed adaxially, adaxial surface shiny, basally attenuate to a petiolar region 2–8 mm, hirsute and stipitate-glandular on both surfaces. **Spikes** 1 or 3(–5) from medial branches, densely to elongate and loose with slightly overlapping fruits, 5–22 cm; floral bracts ovate-lanceolate, slightly shorter than the calyces; rachis stipitate-glandular. **Calyces** 3.5–4 mm, hirsute-hirtellous, stipitate-glandular; lobes triangular, subconnivent. **Corollas** violet to blue, tubes 4–4.5 mm, 1.5–2 mm longer than the calyces, limbs 4–6 mm in diam. **Nutlets** 1.6–2.2 mm, easily separating, commissural ending below the nutlet tips, plates silver-white, mostly bullate or distal sometimes papillate.

Flowering Jun–Oct. Creek sides, rocky slopes, pine-oak woods; 1800–2600 m; N.Mex., Tex.; Mexico (Coahuila).

The existence of *Verbena livermorensis* as a distinct taxon was first pointed out by Turner et al. (2003), who mapped it under that name (unpublished at the time). It is characterized by sparsely bristly-villous, mostly eglandular stems, evenly distributed and even-sized, non-lobed but coarsely serrate leaves with narrowly revolute margins, mostly solitary spikes, and stipitate-glandular calyces.

In the Texas Atlas (Turner et al. 2003), *Verbena livermorensis* was segregated from *V. neomexicana* and the two were mapped as sympatric, each of abundant occurrence in trans-Pecos Texas. In the present study, those collections identified in the Atlas as *V. neomexicana* are *V. hirtella*. Both *V. livermorensis* and *V. hirtella* were identified as *V. neomexicana* by Moldenke (1970) in the Texas Manual. The serrate but essentially unlobed leaves of *V. livermorensis* and *V. hirtella* distinguish them from *V. neomexicana* and *V. xylopoda*.

Additional specimens examined. **USA. New Mexico. Lincoln Co.**: White Mts., gravel loam of E slope, ca. 7900 ft, 30 Jun 1969, *Hutchins 2160* (UNM); White Mts., gravel loam of NW slope, ca. 7400 ft, 24 Oct 1969, *Hutchins 2681* (UNM); White Mts., gravel loam of Three Rivers Campground, ca. 6300 ft, 8 Aug 1970, *Hutchins 3219* (UNM); White Mts., gravel loam, vicinity of Eagle Creek, 6 mi W of Alto, ca. 7600 ft, 3 Aug 1972, *Hutchins 3862* (UNM); Capitan Mts., talus slope, mixed conifer, 2 Oct 1982, *Sivinski s.n.* (UNM); Capitan Mts., along FS Rd 56, ponderosa pine and pinyon-juniper-oak woodland, ca. 2100 m, 1 Aug 1976, *Wagner & Sabo s.n.* (UNM); White Mts., along Ruidoso Creek, 6600 ft, 3 Jul 1895, *Wooton s.n.* (NY); White Mts., Ruidosa, Camp VI, 6600 ft, 3 Jul 1895, *Wooton s.n.* (UNM); White Mts., 7000 ft, 12 Aug 1897, *Wooton s.n.* (NY); White Mts., 7400 ft, 25 Aug 1907, *Wooton & Standley s.n.* (UNM); White Mts., Eagle Creek Canyon, ca. 2500 m, 1 Jul 1984, *Worthington 12179* (NY). **Otero Co.** [labeled as "Lincoln Co.]: Sacramento Mts., North Tularosa Canyon, Mescalero Apache Indian Reservation, 8000 ft, 10 Aug 1931, *Huber s.n.* (MO); White Mtn Wilderness, S-facing slope, open forest, *Pinus ponderosa*, *Q. undulata*, *Q. gambelii*, *Opuntia imbricata*, ca. 2100 m, 18 Sep 1976, *Wagner 2702* (UNM); White Mtn Wilderness, below White Horse Hill along ridge, SSE-facing slope, Doug fir, *Cercocarpus*, *Fendlera*, *Quercus*, ca. 2650 m, 18 Sep 1976, *Wagner s.n.* (UNM). **Texas. Brewster Co.**: in the Laguna of the Chisos Mts., sparse in deep igneous soil, 6000 ft, 10 Sep 1950, *Warnock 9677* (LL, SMU); Chisos Mountains State Park, July 1935, *Marsh s.n.* (TEX); Chisos Mtns., 20 Jun 1931, *Mueller 8138* (TEX), 22 Jun 1931, *Mueller 8138* (MO, NY-2 sheets, TEX). **Jeff Davis Co.**: Davis Mts.: Livermore Peak, 9-12 Jul 1921, *Ferris & Duncan 2607* (NY); Livermore Peak, 9-12 Jul 1921, *Ferris & Duncan 2609* (MO); Mt. Livermore, Upper Limpia Canyon, 15 Sep 1934, *Hinkley s.n.* (TEX-2 sheets); Mt. Livermore, Limpia, 15 Sep 1934, *Hinckley 170* (NY); S slope Mt. Livermore, 8000 ft, 13 Aug 1935, *Hinckley 170* (NY); Limpia Canyon, Mt. Livermore, Jul 1936, *Hinckley s.n.* (ARIZ); Upper Limpia Canyon, ca 1 mi E of Mt. Livermore, ca. 2250 ft, 5 Jul 1936, *Hinckley s.n.* (NY); on gravel and sand bars of creeks, 11 Jun 1926, *Palmer 30791* (TEX); near base of Sawtooth Mtn., amongst rubble along bed of small stream, 3 Oct 1926, *Palmer 31867* (TEX); Black Mt., 13 Aug 1926, *Tharp 4493* (TEX); lower Madera Canyon, mountain NW of Timber Mt., near Hunsaker Resort, 21 Jun 1977, *Weedin & Crabtree 633* (TEX); along jeep trail above creek in lower Madera Canyon, ca. 5500 ft, 29 June 1977, *Weedin & Crabtree 821* (TEX); Fort Davis, 13 Sep 1918, *Young 1703* (TEX). **Presidio Co.**: near summit of Chinati Peak in igneous soils, ca. 7700 ft, scattered perennial herb on upper slopes throughout the Chinatis, 7 Jun 1977, *Butterwick & Lott 3775* (TEX). **Mexico. Coahuila**. Del Carmen Mts., 20 Aug 1936, *Marsh 575* (TEX); Del Carmen Mts., 9 Aug 1936, *Marsh 684* (TEX-2 sheets); Mio. Ocampo, Sierra Madera del Carmen, 3.2 road mi SW of Campo Cinco towards Las Pilares, W-facing slope with *Pinus cembroides*, *Quercus grisea*, *Q. sideroxyla*, *Cercocarpus*, *Juniperus deppeana*, *Stipa tenuissima*, *Muhlenbergia*, etc, 2100 m, 11 Aug 2004, *Riskind et al. 23834* (TEX-2 sheets); Sierra del Carmen, Fresno Mesa, 28° 88.75' N, 102° 52.68' W, oak woodland, 1927 m, 2 oct 1997, *Wood et al. s.n.* (UNM); Mpio. Villa Acuña, Sierra del Carmen, Canyon de Sentenela on Hacienda Piedra Blanca, moist stream side, 6 Jul 1936, *Wynd & Mueller 525* (MO, NY).

The duplicate of *Wynd & Mueller 525* at TEX is *Verbena hirtella*.

8. VERBENA MORANII Nesom, **sp. nov.** **Fig. 4, Map 1.** **TYPE: Mexico. Baja California.** [Sierra San Pedro Martir], ca. 4 km N, 60 degrees E of Cerro Piñon, 31° 38.5' N, 115° 59.75' W, occasional on metamorphic hill, 1100 m, 18 Sep 1977, *R. Moran 24936* (holotype: LL!;

isotype: LL!, SD). Moran's field notebook (Moran 2009) indicates that 4 duplicates in total were collected.

Verbenae pinetorum similis sed differt vestimento caulini glandulosi eglandulosi redacti sed distinctus caulibus plerumque glabris eglandulosis et calycibus proprie sessili-glandulosis.

Plants perennial herbs, taprooted. **Stems** 3–10 from the base, erect to ascending-erect, ca. 30–70 cm, glabrate to sparsely hirsutulous or hirsutulous-hirtellous, sparsely sessile- to stipitate-glandular. **Leaves** obovate to oblanceolate, ovate, or lanceolate in outline, basal and lower cauline deciduous by flowering, midstem blades 1.5–3.5 cm x 4–11 mm, margins coarsely serrate with 1–4 teeth per side, sometimes 3-lobed or pinnately lobed, veins impressed adaxially, hirsutulous to hirsute-villous adaxially, stipitate-glandular, hirsute abaxially mostly along the veins, basally attenuate to a petiole 3–12 mm. **Spikes** 1 or 3(–5) from distal branches, dense to open-elongate, 8–20(–30) cm; rachis hirtellous-hirsutulous, minutely stipitate-glandular; floral bracts ovate-lanceolate, usually equal or shorter than the calyces. **Calyces** 3.5–4 mm, hirtellous to hirsute-hirtellous, densely minutely sessile- to stipitate-glandular, lobes narrowly triangular, connivent. **Corollas** light blue to deep blue, tubes 3.5–5(–6) mm, 1–3 mm longer than the calyces, limbs (2.5–)3–5 mm in diam. **Nutlets** 2–2.5 mm, commissural faces ending below the nutlet tips, plates white, densely bullate-papillate.

Flowering Apr–Oct. Rocky slopes; 780–1425 m; Mexico (Baja California).

Verbena moranii is distinct in its glabrate to sparsely hirsutulous stems and characteristically sessile-glandular calyces. The collections by Moran are from a relatively small area of the Sierra San Pedro Mártir, between 31° 05' to 44' N and 115° 53.5' to 116° 02' W. The species is named for Reid Moran. Dr. Moran died 21 Jan 2010 at age 93 (Gonzalez 2010; Kent 2010; Vanderplank 2010).

Additional collections examined. **Mexico**. **Baja California**. Granitic soil on foothills of Sierra San Pedro Martir in vicinity of Rancho San Jose, 25 mi E of San Telmo, 2600 ft, 23 Feb 1931, *Meling 3* (NY); 3 mi S of El Alamo, locally common on upper S slope of Cerro Piñon, 31° 38' N, 116° 01' W, 1425 m, 30 May 1970, *Moran 17658* (LL, plus 4 duplicates, fide Moran 2009); 2 mi W of Cerro Colorado, 31° 44' N, 116° 02' W, granitic soil of valley, occasional on rocky hillside, 1025 m, 21 May 1973, *Moran 20983* (LL, plus 3 duplicates); limestone Cerro El Bromador, occasional on SE slope, 31° 05' N, 115° 53.5' W, 780 m, 1 Jun 1976, *Moran 23387* (LL, plus 3 duplicates).

9. **VERBENA NEOMEXICANA** Small, Fl. S.E. U.S., 1010, 1337. 1903. **Map 8**. *Verbena canescens* var. *neomexicana* A. Gray, Synopt. Fl. N. Amer. 2(1): 337. 1878 [nom. illeg. superfl., as "Neo-Mexicana"]. *Verbena officinalis* var. *hirsuta* Torrey, Rep. U.S. and Mex. Bound., Bot. 2(1): 128. 1859. **NEOTYPE** (designated here): **USA. New Mexico**. [Grant Co.]: Borders of thickets, near Copper mines, 1851, *C. Wright 1497* (GH digital image!; isoneotypes: MO!, US digital image!). In Gray's description of *Verbena canescens* var. *neomexicana*, he placed Torrey's earlier *V. officinalis* var. *hirsuta* in synonymy, noting "Borders of thickets near the Coppermines, New Mexico, *Wright, Bigelow*. Appears as if a hybrid between *V. canescens* and *V. officinalis*. S. Arizona, similar in foliage but with long bracts, *Rothrock*." *Wright 1497* at GH is mounted on the same sheet as a Rothrock collection (Arizona. Fisch's Ranch, 5000 ft, Sep 1874, *J.T. Rothrock 693*).

In the protologue of *Verbena officinalis* var. *hirsuta*, the only collection cited by Torrey was "Near the Copper Mines, New Mexico, June; *Bigelow*." In his personal printed copy of the Botany of the Mexican Boundary Survey, however, Torrey penciled in "827" next to the text entry for *V. officinalis* and "827a" next to *V. officinalis* var. *hirsuta*. At NY are two specimens with printed labels as "Mexican Boundary Survey, … chiefly in the Valley of the Rio Grande, below Donana" and noting Parry, Bigelow, Wright, and Schott as collectors; both specimens are hand-numbered as "827" but have no other particular collector or locality

information. These plants, however, are *V. hirtella* and surely were collected in southwestern Texas, not in in the vicinity of the Copper Mines in Grant County, New Mexico.

Charles Wright and John Bigelow, along with George Thurber, Charles C. Parry, and Arthur Schott, all were part of the 1851 United States and Mexican boundary survey. Wright and Bigelow were both at the Copper Mines (but not Thurber, Parry, or Schott) and perhaps were collecting side by side. Torrey's 1859 protologue and Gray in 1878 both referred to Bigelow as the collector of *Verbena* from "near the Copper Mines," but the only specimens to be found from that locality are those labeled specifically as Wright's 1497, which is designated as the neotype.

Because Small's combination was based on an illegitimate name at varietal rank, *Verbena neomexicana* at specific rank is attributed solely to Small. As the basis of his combination, Small cited only "*Verbena canescens* var. *Neo-Mexicana* A. Gray." The original Bigelow collection cited by Torrey underlies all of the nomenclature but it has not been located in the present study and is supplanted by a neotype.

Verbena ×neomexicana Briquet (Nat. Pflanzenfam. IV, 3a: 148. 1894) was invalidly published (without a type or description)—it was intended as a name for a hybrid ("V. canescens x officinalis") and did not represent the same entity as Gray's "var. *neomexicana*."

Perennial herbs, taprooted. **Stems** 1–5 from the base, erect to ascending-erect, 30–70 cm, moderately hirsute with slightly upturned and/or downturned hairs, moderately stipitate-glandular. **Leaves** even in distribution and shape, basal and lower cauline usually deciduous by flowering, largest at midstem and above, mostly oblong in outline, pinnatifid to deeply pinnately toothed with 3–5 teeth or lobes per side, sometimes 3-lobed, blade midportions evenly oblong, midstem 2.5–5.5 cm x 10–20 mm, petiolar region not differentiated or 5–10 mm if so, veins slightly or not impressed adaxially, margins barely revolute or not at all, both surfaces hirsute, sparsely stipitate-glandular. **Fruiting spikes** 1–6 from medial and distal branches, 2–10(–14) cm, elongate and loose with non-overlapping fruits; rachis hirsute, stipitate-glandular; floral bracts 2–2.5 mm, ovate-triangular, shorter than the calyces. **Calyces** 2.5–3 mm, hirsute and hirtellous, stipitate-glandular, lobes triangular to lanceolate. **Corollas** blue to white, tubes 2.5–4 mm, 0.5–1 mm longer than the calyx, limbs 1.5–2.5 mm in diam. **Nutlets** 1.4–1.8 mm, commissural faces extending to the nutlet tip, densely minutely bullate, outer surfaces reticulate.

Flowering (Apr–)Jul–Sep. Juniper-oak, pine-oak, and ponderosa pine woodland; 1600–2300 m; Ariz., N.Mex.; Mexico (Chihuahua).

Verbena neomexicana as a species as treated here is narrower in concept than in most previous accounts, except for that of Perry (1933), who recognized three varietal taxa whose biological reality is confirmed in the present study (also see comments in the introduction of this manuscript). Although her identifications were not entirely consistent, Perry's distinctions based on differences in vestiture were valid. Each of the three varieties recognized by Perry is treated here at specific rank.

An interesting feature of *Verbena neomexicana* sensu stricto is that it may be more closely related to *V. menthifolia* Benth. and *V. madrensis* Nesom (series *Verbena*, see Nesom 2010) than to the species of ser. *Tricesimae*, those treated in the current overview. Commissural faces of nutlets in *V. neomexicana* extend to the very tip of the nutlet, in contrast with the other species here but similar to the species of ser. *Verbena*. Spikes of *V. neomexicana* tend to be relatively short, and the inflorescence branches are irregularly cymose and arise from medial and distal branches, also in contrast to ser. *Tricesimae*, where spikes are mostly solitary or few from proximal to medial branches, and more similar to those of ser. *Verbena*. *Verbena neomexicana* is distinguished from *V. xylopoda* by the set of contrasts below.

1. Stems loosely hirsute; leaves evenly distributed, basal and lower cauline not persistent; spikes from from medial to distal branches; corolla tubes 2.5–4 mm, limbs 1.5–2.5 mm in diam.; nutlets with commissural faces reaching the tip ..... **Verbena neomexicana**
1. Stems hispidulous to hirsutulous; leaves largest and often persistent basally and proximally; spikes from proximal to medial branches; corolla tubes 4–5 mm, limbs (3–)4–6(–7) mm in diam; nutlets with commissural faces not reaching the tip ..... **Verbena xylopoda**

Additionally, the leaves of *V. neomexicana* tend to be thinner with barely revolute margins and without veins deeply impressed adaxially.

Additional specimens examined. **USA. ARIZONA. Cochise Co.**: Chiricahua Mts., Gulching Ground, Pine Canyon, campsite, 6700 ft, 5 Jul 1907, *Blumer 1612* (NY); Chiricahua Mts., Apache Pass, May 1881, *Lemmon 425* (ARIZ). **Graham Co.**: Santa Theresa Mts., Tule Springs, riparian woodland, 4800 ft, 25 Apr 1970, *Bingham 1741* (ASU digital image!). **NEW MEXICO. Catron Co.**: Gila Cliff Dwellings Natl. Monument, Cliff Dweller Canyon, E-facing slope, douglas fir-juniper-oak-walnut, 5815 ft, *Bennett 174* (ARIZ); Gila Cliff Dwellings Natl. Monument, Cliff Dweller Trail, ponderosa pine forest, tiny white flowers, 1795 m, 19 Jul 2001, *Bennett 902* (ARIZ); ravine below Gila Cliff Dwellings, deep ravine with springs seeping and a small stream, pinyon and juniper on the steep rocky sides and Douglas fir, *Ptelea*, *Rhamnus*, and *Prunus* in the ravine, 6000-6500 ft, 5 Jul 1952, *Dunn 8334* (UNM); near Luna, Datil Forest, 2140-2200 m, 17-20 Jul 1924, *Eggleston 20292* (NY); Datil Mts., Thompson Cave, volcanic soil, 8200 ft, 20 Jul 1976, *Fletcher 763* (UNM). **Grant Co.**: Pinos Altos Mts. [just N of Silver City], 23 Aug 1880, *Greene 12505* (MO, NY); 5.5 mi E of Santa Rita, 6500 ft, 15 Sep 1972, *Zimmerman 2239* (ARIZ). **Hidalgo Co.**: Peloncillo Mts., W of Cloverdale, Maverick Canyon, shady oak woods, 22 Aug 1955, *Castetter 9915* (UNM). **Socorro Co.**: Magdalena Mts., gravel loam of Sawmill Canyon, ca. 6700 ft, 16 Jun 1973, *Hutchins 4221* (UNM). "**Socorro Co.**" [or perhaps **Catron Co.**]: Mogollon Mts., on or near the West Fork of the Gila River, ca. 7000 ft, 28 Aug 1903, *Metcalfe 612* (ARIZ, MO, NY). **Sierra Co.**: [Black Range], bottom of Tierra Blanca Canyon, 6800 ft, upper woodland and yellow pine, 18 Aug 1916, *Chapline 609* (NY). **County unknown**: Pleasant Valley, 27 Jul 1895, *Mulford 508* (MO). **MEXICO. CHIHUAHUA**. Ca. 12 air mi WSW of Buenaventura, Rancho de la Tinaja, steep-sided canyons with frequent seasonal drainage, area dominated by pine and oak, 2000-2100 m, 30 Aug 1989, *Mayfield 190* (TEX).

Lemmon 425 from the Chiricahua Mountains in Cochise County has features suggestive of genetic influence from *Verbena plicata* Greene. *Blumer 1612* is typical of *V. neomexicana*.

Citations of *Verbena neomexicana* from Texas by Moldenke and others are based on misidentification of various species, primarily *V. hirtella* and *V. livermorensis*. Moldenke (1964) cited a collection of *V. neomexicana* from Maryland (near Baltimore, 1866, *LeRoy s.n.*, NY) and from Florida (county unknown, no collection data, VT)—these were either waifs or misidentifications and the species has never been subsequently reported from those states.

10. VERBENA PERENNIS Wooton, Bull. Torrey Bot. Club 25: 262. 1898. **Map 9. TYPE: USA. New Mexico**. Lincoln Co: crevices of rocks along the road about 2 miles west of the Mescalero Agency in the White Mtns, 6000 ft, 21 Jul 1897, *E.O. Wooton 187* (holotype: US-digital image!; isotypes: GH-digital image!, MO!-digital image!, NMC, NY! NY-digital image!, PH fide Perry (1933); US-digital image!).

Plants perennial herbs to subshrubs, taprooted. **Stems** 5–20 from the base, 15–35 cm, glabrous to glabrate, sparsely hispidulous, hispid-strigose, or hirsute-strigose, eglandular. **Leaves** linear, basal and lower cauline deciduous by flowering, midstem (5–)10–25 mm x 0.6–1.6 mm,

margins entire or proximal with a pair of linear teeth or lobes, revolute and usually obscuring the abaxial surface, sparsely hispid-strigose, eglandular; sessile. **Spikes** solitary or 2–3 from proximal branches, elongate and slender, 3–12 cm; floral bracts ovate-lanceolate, 2–3 mm, shorter than the calyces. **Calyces** 3.2–4 mm, hirtellous to hispid-strigose, minutely stipitate-glandular, lobes linear-lanceolate, not connivent. **Corollas** blue to purple or purplish lavender, without a white throat, tubes 4.5–6 mm, 1.5–2 mm longer than the calyx, limbs 5–8 mm in diam. **Nutlets** 1.8–2.1 mm, commissural faces not reaching nutlet apex, with bullate plates.

Flowering (Mar–)Apr–Sep. Rocky hillsides, roadsides, thorn scrub-grassland, juniper, pinyon-juniper, oak-juniper-pine; 1500–2000 m. USA (New Mexico, Texas; Mexico (Coahuila).

Kearney & Peebles (1960) cited a collection of *Verbena perennis* from Arizona: "Pima Co.: Baboquivari Mts., *Jones 24994*." This collection has not been located in the present study, but it is far out of range for the species and presumably either misidentified or mislabeled.

Collections examined from Mexico: **Coahuila**. 24 km by winding rd N of Las Norias toward Chupadero del Caballo, SW of Cañon del Colorado, 102º 12' 0.0", 29º 21' 0.0", limestone hills with *Dasylirion*, *Quercus*, *Rhus*, 12 Sep 1972, *Chiang, Wendt & Johnston 9178* (LL); ca. 22 (air) mi due E of Boquillas, due NE of Pico de Sentenela of the Sierra del Carmen, 3 mi E of Rancho Piedra Azul, 102º 33' 0.0", 29º 8' 0.0, rocky limestone slopes with *Dasylirion*, *Yucca*, *Acacia*, *Hilaria*, *Mimosa*, *Dalea*, 26 Jul 1973, *Henrickson 11366* (TEX); Muzquiz, Cd. de Melchor Múzquiz, about 100 mi NW of, Sierra Hermosa, Rancho La Morada of Mr. And Mrs. Aldan McKellar, 102º 32' 36.18", 28º 54' 23.2", 12 May 1968, *Latorre s.n.* (TEX); Del Carmen Mts., 9 Jun 1936, *Marsh 859* (TEX-2 sheets); Santa Rosa Mts., 14 Jul 1938, *Marsh 1378* (TEX); Muzquiz, Cd. de Melchor Múzquiz (Múzquiz), ca 140 Km NW rd of on Coa Hwy 2A (Mzq.-Boquillas), Cuesta del Plomo area, ca 0.5 rd mi S on rd originating just SE of crest of 2A, 102º 19' 59.31", 28º 40' 10.37", limestone area, scattered pine-oak woodlands with *Yucca* and *Dasylirion*; ridge top and sides, dry ravine with shade banks; meadow, mostly along slopes of small stream, also in low meadow, 4 Jun 1992, *Nesom 7462* with Mayfield (TEX).

The westernmost collection from New Mexico is this: **Sierra Co.**: Berendo [Berrenda] Creek, in and around the S end of the Black Range, limestone hills, 5500 ft, 13 May 1905, *Metcalfe 1568* (MO!, NMC fide SEINet and Rich Spellenberg, NY!). A collection was mistakenly databased (SEINET) as *Verbena perennis* from Grant Co., New Mexico, but this is actually from Lincoln County ([Lincoln Forest], lower part of Cave Cañon, 11 Sep 1916, *Chapline 652*, NMC).

11. VERBENA PINETORUM Moldenke, Phytologia 2: 27. 1941. **Map 10**. **Type**: **Mexico**. **Chihuahua**. Sierra Charuco, Rio Fuerte, pine flats, transition habitat, 23 Jul 1935, *H.S. Gentry 1522* (holotype: ARIZ, digital image!, photo-NY!; isotypes: ARIZ digital image!; MO!). The ARIZ isotype is dated "22" July, but this probably was a typo since all other data, including the collection number, are identical. The MO label exactly duplicates the holotype label.

Plants perennial, taprooted. **Stems** 1–5 from the base, erect to ascending-erect, 25–60 cm, sparsely to moderately hirsute-villous to bristly-hirsute, eglandular. **Leaves** ovate to lanceolate in outline, all pinnatifid or 3-lobed, lobe margins coarsely serrate, basal and lower cauline deciduous by flowering, midstem blades 2–4 cm x 8–17 mm, hispid-hirsute, eglandular; petiolar region 3–15 mm. **Spikes** 1 or 3(–5) from medial to distal branches, elongate and slender, (3–)6–21 cm; floral bracts narrowly triangular to narrowly ovate-triangular, slightly longer to slightly shorter than the calyces. **Calyces** 3.5–4 mm, hirsute to hirtellous, sparsely minutely stipitate-glandular, lobes triangular, connivent to subconnivent. **Corollas** lavender, purple, blue-violet, or pink-purple, tubes 4.5–5.5 mm,

1–1.5(–2) mm longer than the calyces, limbs (5–)6–9 mm in diam. **Nutlets** 1.8–2 mm, commissural faces not reaching nutlet apex, densely bullate-papillate.

Flowering Jul–Sep(–Oct). Oak-pine-maple, pine-oak, oak-juniper, pine-oak-juniper, and oak and oak-manzanita woodland, rocky and gravelly slopes, roadsides, ditches, disturbed sites; 1300–2200(–2700 in Mexico) m; USA (Arizona); Mexico (Chihuahua, Sonora).

Verbena pinetorum is distinctive in its hirsute-villous to bristly-hirsute, eglandular stems, pinnatifid basal and cauline leaves, and large flowers (calyces and corollas). Based on their reading of the protologue, O'Leary et al. (2010) treated it as possibly a synonym of *V. neomexicana* var. *neomexicana*, noting that they were not able to locate the type specimen after consulting herbaria housing collections of "F. Shreve." Moldenke (1964b), however, clearly indicated that the type is deposited at the University of Arizona.

Additional specimens examined. **USA. ARIZONA. Cochise Co.**: Huachuca Mts., Garden Canyon, 3 Sep 1928, *Harrison & Kearney 5796* (ARIZ); Huachuca Mts., Sunnyside, 6000 ft, 3 Oct 1937, *Kearney & Peebles 13847* (ARIZ); SW side of Huachuca Mts., gentle rocky slope of W side Scotia Canyon, oak-juniper woodland, 6000 ft, 14 Sep 1988, *McLaughlin 5245* (ARIZ); Parker Canyon Lake Recreation area, juniper-grassland and riparian, 12 Oct 1968, *Pinkava et al. 14553* (NY-2 sheets); Huachuca Mts., 3.5 mi WNW of Montezuma Pass on Parker Canyon Road, 5700 ft, oak woodland, 11 Aug 1990, *Van Devender 90-348* (ARIZ); Ft. Huachuca, Aug 1892, *Wilcox s.n.* (NY); Huachuca Mts., Bear Canyon, scattered plants in canyon bottom near stream, 5800 ft, 26 Sep 1980, *Yatskievych 80-743* (ARIZ). **Santa Cruz Co.**: Ruby, 23 Aug 1939, *Darrow s.n.* (ARIZ); W slope of Atascosa Mts., Sycamore Canyon, Goodding RNA, canyon bottom, riparian, 7 Sep 1987, *Franklin 5402* (NY); Sycamore Canyon, 30 Aug 1938, *Goodding 6009* (ARIZ); Sycamore Canyon, 23 Jul 1967, *Hesselberg s.n.* (ARIZ); near Ruby, rocky canyon side between Bear Valley Ranch and Penasco Canyon, 3850 ft, 20 Aug 1949, *Kaiser 49-248* (ARIZ); Pena Blanca-Ruby Road, ca. 2 mi E of Ruby, oak-manzanita woodland, 1310 m, 11 Aug 1999, *McLaughlin 8017* (ARIZ); Sycamore Canyon, Goodding Research Natural Area, 3500 ft, 23 Aug 1974, *Reeves R1198* (NY); Santa Rita Mts., Gardner Canyon, 27 Aug 1977, *Van Devender & Kearns s.n.* (ARIZ, LL). **MEXICO. CHIHUAHUA**. Mesa La Pulvosa, 7 km SSE of Talayotes, active airstrip of Col. Davis in the 1950s, serving La Republica Mine, in open road of former pine-oak-madrono forest, 12 Aug 1958, *Commisaris s.n.* (ARIZ); ca. 35 mi from Temosachic, along Hwy 16, roadside area, returning from Madera, pinyon pine-oak forest, 7900 ft, 3 Aug 1977, *Dunn et al. 22610* (MO, NY, TEX); Pinos Altos, barrens of juniper, bare ground, 2250 m, 27 Jun 1986, *Ferguson s.n.* (ARIZ); along road from Las Chinacas to Huicochic, 3 mi N of Las Chinacas, ca. 40 km NW of Alamos, 1500 m, S-facing slope with seeps on road cut below cultivated fields in pine-oak forest, 22 Aug 1993, *Fishbein 1350* (ARIZ); Yécora, vicinity of cabañas on old road to Maycoba, 0.5 mi E of Arroyo Yécora, open pine-oak forest, 1550 m, *Fishbein 2469* (ARIZ); Sierra Charuco, Rio Fuerte, transition, pine region, scarce on dry gravel benches and slopes, 11 Sep 1935, *Gentry 1758* (ARIZ, MO); Cerro Quicorichi [27.75°, 108.65°, between Las Chinacas and La Lobera on road to Chinipas] Rio Mayo, transition, open pine slope, 5000 ft, 3 Oct 1935, *Gentry 1923* (ARIZ); Sierra Charuco, Rancho Byerly, rocky igneous slopes, pine-oak forest, 5000-58000 ft, 17-25 Apr 1948, *Gentry 8150* (ARIZ); 6.4 mi W of Cocheño Bridge on Hwy 16, disturbed roadside, 28 Jul 1988, *Hathaway & Holm s.n.* (ARIZ); Cuiteco, rocky field, 18 Jul 1958, *Knobloch 935* (SMU); Nabogame, 28° 30', 108° 30', field, 1800 m, 29 Jul 1987, *Laferriere 587* (TEX); Mpio. Madera, Laguna de Babicora, Cerro La Concha, pino-encino, 2450 m, 18 Aug 1994, *Lebgue et al. 3202* (NY); Las Varas, 12.8 km W of Yepachi, rocks in oak woodland, 1600 m, 22 Oct 1984, *Levin 1469* (LL); Pinos Altos, barrens of juniper, bare ground, 2250 m, 26 Jul 1986, *Martin et al. s.n.* (ARIZ); Rio Mayo drainage 1 km SE of mining town of Concheño, 2100 m, pine-oak forest with patches of altered soil, 4 Jul 1992, *Martin & Barber s.n.* (ARIZ); Rancho El Rayo between Las Chinacas and La Lobera on road to Chinipas, 1500 m, pine oak woods, small arroyo bottom and hillslope, 18 Aug 1991, *Martin & Yetman s.n.* (ARIZ); roadside W of Ocampo

near Km 32, 2050 m, NE exposure, 25 Jul 1986, *Martin et al. s.n.* (ARIZ); near sawmill, El Campo (El Serrochito on 1:50,000 map), 2000 m, Rio Mayo drainage, 14 Aug 1982, *Martin & Mellink s.n.* (ARIZ); ca 9.8 mi E of Madera on Hwy 28 (37 by road sign) and 3.8 mi E of RR crossing with the same Hwy at Preson de Galondrinas, wet roadside ditch with *Polygonum*, 2170 m, 31 Aug 1989, *Mayfield 280* (TEX); Mpio. Temosachic: common on rocky slopes in open pine-oak forest, Canon Huahuatan, 10 mi SE of Madera, 23 Sep 1939, *Muller 3427* (LL); Yepachic, 16 Jul 1970, *Pennington 43* (TEX); Mpio. Madera, Laguna de Babicora, alrededores de El Alamillo, bosque pino-encino, 2200, 18 Aug 1994, *Quintana & Estrada 3146* (BRIT, NY); Mpio. Madera, Laguna de Babicora, Arroyo El Jaral, bosque de pino-encino, 2300 m, 10 Sep 1994, *Quintana & Estrada 3589* (NY); ca 40 km E of Chuhuichupa along the road to Las Varas, 20 km SE of Mesa del Hurucan, 29° 37' N 108° 11' W, deep canyon in volcanic tuff, oak-pine-maple woodlands, 2000 m, 9 Aug 1977, *Sanders 1049* (TEX); Mpio. Ocampo: Parque Nacional "Cascada de Basaseachic," in shallow soil over bedrock near the Divisadero overlook, open juniper, pine, oak, 2200 m, 31 Jul 1988, *Spellenberg et al. 9559* (NY, TEX); 10 mi NW of Pacheco/Willy jct on road to Rancho Willy, in pine-oak-manzanita community, white chalky soil, ca. 6000 ft, 11 Jul 1997, *Spencer & Atwood 586* (TEX); Basaseachic Falls, pine-oak forest, 6800 ft, 14 Jun 1984, *Titley s.n.* (ARIZ); near Colonia Garcia in the Sierra Madres, 7500 ft, 29 Jul 1899, *Townsend & Barber 192* (MO, NY, TEX); 82 mi (road) W of Vieja Casas Grandes, 6500 ft, pine-oak woodland, 25 Aug 1952, *Tucker 2508* (LL, ARIZ); 15 mi E of Madera, 7200 ft, 8 Aug 1976, *Walker 76H37* (MO, NY); along road between Babicora and Yepomera in yellow pine forest, near the divide, 8000 ft, 4 Aug 1977, *Wieder et al. 236* (MO); 14 km ENE of Colonia Pacheco, on the winding road to Colonia Juarez, 2150 m, gentle slopes of extrusive igneous rock, with oak and pine, 31 Jul 1972, *Wilson & Johnston 8510* (LL); Mpio. Ocampo, 2 km antes de Cieneguita, *Pinus-Juniperus*, 2000 m, 5 Aug 1994, *Yen & Estrada 2778* (BRIT). **SONORA.** Mesa Grande, willow oak-Apache pine-juniper, 1800 m, 12 Aug 1987, *Martin & Kryzanowski s.n.* (ARIZ); Mesa El Campanero between Yecora (Sonora) and Bermudez (Chihuahua), pine-oak forest, 17 Aug 1985, *Martin & Turner s.n.* (ARIZ); 20 km W of Yecora, abundant on disturbed slopes with *Penstemon campamulatus*, 17 Aug 1991, *Neff 91-10* (TEX); Maicoba, 20 Jul 1970, *Pennington 66* (TEX); Maicoba, 5000 ft, Jun 1968, *Pennington 74* (TEX); Yecora, 3 Aug 1970, *Pennington 98* (TEX); Yecora, baseball field next to the cemetary, camping site, disturbed and grazed, 5 Sep 1996, *Porter 11150* (TEX); 1.6 km S of Tierras de Ascensio, ca. 7.6 km (by air) W of Yecora, 2.5 km ENE of microwave tower on Mesa del Campanero, pine-oak forest, 1780 m, 8 Aug 2000, *Reina G. 2000-415* (ARIZ); Los Pilares, Arroyo Los Pilares, ca. 23 km E of Yecora, 26 km W of Maycoba on Mexico 16, 1260 m, 8 Sep 1995, *Reina G. 95-470* (ARIZ); Ranchito Pinos Altos, Sierra Nacori, riparian oak woodland, 2 Aug 1969, *Robinson s.n.* (ARIZ); Sierra de Mazatán, Mpio. de Ures, Represo 0.3 km SW del Rancho El Bachán, bosque de encino, 1440 m, 3 Oct 2003, *Sanchez & Espericueta s.n.* (ARIZ); Mpio Yecora, Puerto de la Cruz, N base of Mesa del Campanero, pine-oak forest, 28 22 37, 109 02 20, 1900 m, 8 Sep 1996, *Van Devender 96-497* (TEX); Rancho de la Nacha, region of the Rio de Bavispe, oak-grassland, 4300 ft, 17 Aug 1941, *White 3985* (ARIZ); El Rancho del Roble, NE of El Tigre, region of the Rio de Bavispe, 6000 ft, 2-13 Sep 1941, *White 4176* (ARIZ).

Moldenke (1964b) cited an Arizona collection of *Verbena pinetorum* as from Pima Co. (Old Baldy, 28 Aug 1904, *S.L. Berry s.n.*, CAS), but surely this is from Old Baldy of the Santa Rita Mountains of Santa Cruz County. He also cited collections from Durango, Nuevo León, and San Luis Potosí, which are out-of-range for *V. pinetorum* and instead probably some other species.

Another collection, intermediate in vestiture, may be a hybrid between *Verbena pinetorum* and *V. xylopoda* (Cochise Co., [Huachuca Mts.,] Sunnyside to Elgin, 5330 ft, 3 Oct 1937, *Kearney & Peebles 13863*, ARIZ).

12. VERBENA SUBULIGERA Greene, Pittonia 1: 156. 1888. **Map 2**. **LECTOTYPE** (designated here): **Mexico**. Durango. From the Sierra Madre, west of Durango, 8100 ft, Sep and Oct

1881, *A. Forrer s.n.* (NY! digital image!; isolectotypes: ARIZ!, F digital image!, GH digital image!, MO!, PH, UC fide Moldenke 1965, US digital image!). There is no specimen of *Verbena subuligera* at ND-Greene, fide Barbara Hellenthal. The NY sheet has Greene's annotation as "*Verbena subuligera* n. sp." and his handwritten notation of the publication information in Pittonia.

Perennial herbs, taprooted. **Stems** 1–4 from the base, few-branched, erect to ascending-erect, sometimes decumbent-ascending at the base, 8–30 cm, hirsute and hirsutulous, eglandular or sparsely stipitate-glandular near the base. **Leaves** oblong to oblong-oblanceolate or oblong-lanceolate in outline, pinnately toothed or lobed with 4-6 sharply acute, antrorse or slightly recurving teeth or lobes per side, sometimes 3(–5)-lobed, midportion generally oblanceolate, midstem 13–25 mm x 5–10 mm, relatively evenly distributed, basal usually deciduous by flowering, petiolar region 2–6 mm, sparsely hirsute, glandular. **Fruiting spikes** 1–2(–3) from distal branches, congested with overlapping flowers and fruits, 2–8 cm; floral bracts linear-lanceolate to narrowly ovate-lanceolate, 3.5–5 mm, usually to twice longer than the calyces, spreading at right angles; rachis glandular. **Calyces** 2.8–3 mm, strigose-hirsute to hirsute-hirsutulous, stipitate-glandular, lobes deltate, mucronate, erect, subconnivent. **Corollas** blue to purple, tubes 3.5–3.8 mm, 0.3–0.5 mm longer than calyces, limbs 1.5–2.5 mm in diam. **Nutlets** easily separating at maturity, 1.5–1.8 mm, commissural faces ending below the nutlet tips, low-papillate.

Flowering (Jul–)Aug–Oct. Pine and oak woods; 2000–2700 m; Mexico (Durango).

Additional collections. **Mexico**. Durango. El Salto, encino, 9 Jul 1982, *Hernandez 7770* (ARIZ); [or] west of Durango, pino, encino, 2000 m, 22 Jul 1982, *Hernandez 8143* (ARIZ); pine covered mountain top, 17 mi W of El Salto, 12 Aug 1956, *Waterfall 12703* (OKLA digital image!, MICH fide Moldenke 1965); open pine woods, 6 mi SW of El Salto, 14 Aug 1959, *Waterfall 15504* (OKLA digital image!).

Greene (1888) noted in the protologue that *Verbena subuligera* was "Near *V. bracteosa* [= *V. bracteata*], with which it agrees well in habit; but the nutlets in that familiar species are a line long and have a sharply rugose back, and a commissure fully coextensive with the nutlet" [vs. nutlets "only faintly striate on the back, the scabrous commissure occupying about four-fifths the length of the nutlet"]. Perry (1933) included the species in her treatment, essentially repeating the contrasts by Greene, and Perry was quoted by Moldenke (1965). O'Leary et al. (2010) have treated *V. subuligera* as a synonym of *V. bracteata*.

When I first saw the MO isotype of *Verbena subuligera*, and having seen only that specimen, I thought it might be a rarely formed hybrid, perhaps between *V. bracteata* and some other species, but after seeing other isotypes and three independent collections (as cited above) of very similar plants from the same area, their morphological consistency and geographical coherence indicate that *V. subuligera* is a distinctive species, albeit apparently a narrow endemic. Among the sheets that I have studied first-hand and those examined from digital images, at least 8 plants appear to be represented among the four separate gatherings.

Verbena bracteata is not a member of the *V. neomexicana* group. Its eglandular vestiture, distinctly petiolate, incised leaves, and nutlets with commissural faces extending completely to the tip are similar to those of *V. xutha* Lehm. (Nesom 2010a). Major differences between *V. subuligera* and *V. bracteata* are presented in the contrasts below.

1. Stems erect to ascending-erect, sometimes decumbent-ascending at the base; stems hirsute and hirsutulous; stems, leaves, rachises, and calyces stipitate-glandular; leaves narrower in outline, mostly oblanceolate, without a distinctly defined petiolar region; floral bracts linear-lanceolate to narrowly

ovate-lanceolate, weakly accrescent or not at all, 3.5–5 mm long; commissural faces ending below the nutlet tips ..... **Verbena subuligera**
1. Stems prostrate or procumbent to decumbent-ascending; stems sparsely hirsute to villous; stems, leaves, rachises, and calyces eglandular; leaves broader in outline, obovate to oblong-obovate or oblanceolate, usually with an abruptly delimited petiolar region; floral bracts lanceolate to elliptic-lanceolate, strongly accrescent, (5–)6–15 mm long; commisural faces extending to very tip of nutlets ..... **Verbena bracteata**

13. VERBENA XYLOPODA (Perry) Nesom, comb. et stat. nov. **Map 11**. *Verbena neomexicana* var. *xylopoda* Perry, Ann. Missouri Bot. Gard. 20: 297. 1933. **TYPE: USA. Arizona.** Pima Co.: Santa Catalina Mts., Sabino Canyon, rocky slopes, infrequent, 21 Apr 1922, *H.C. Hanson A1130* (holotype: MO!, digital image!).

Perennial herbs, taprooted. **Stems** 1–5(–10) from the base, erect to ascending-erect, 20–55(–70) cm, moderately to densely hispidulous to hispidulous or hirsutulous with short, narrowly triangular to linear-triangular eglandular hairs and sparsely sessile- or subsessile- to short-stipitate-glandular. **Leaves** largest and often persistent basally and proximally, mostly ovate to subspatulate, obovate, or oblanceolate in outline, pinnatifid to deely pinnately toothed with 3–4 lobes or teeth per side, sometimes strongly 3–5-lobed, midregion oblanceolate and broadening distally (cf. *V. neomexicana*), basal and lower cauline blades (1–)2–5(–7) cm x 5–15(–25) mm, petiolar regions 5–15(–20) mm, veins impressed adaxially, margins narrowly revolute, distal cauline usually becoming narrower, often linear and entire to toothed, hispidulous and hirsutulous and short-glandular on both surfaces. **Fruiting spikes** 1 or 2–5 from mostly proximal to medial branches, 4–20(–27) cm, elongate and loose with non-overlapping to slightly overlapping fruits; rachises hispidulous and densely stipitate-glandular; floral bracts ovate-lanceolate to narrowly triangular, 3–4 mm, shorter than or equal the calyces; rachis hispidulous to hispidulous-hirsutulous, stipitate-glandular. **Calyces** 2.5–3.5(–4) mm, hispidulous to hirsutulous, subsessile- to short-stipitate-glandular, lobes lanceolate to narrowly triangular, loose, erect, subconnivent or not at all. **Corollas** blue to violet, tubes 4–5 mm, 1–2(–2.5) mm longer than calyx, limbs 4–7(–8) mm in diam. **Nutlets** 1.6–2.2 mm, commissural faces not reaching the nutlet apex, densely bullate, outer surface reticulate.

Flowering (Mar–)Apr–Oct. Rocky slopes, crevices, roadsides, grassland, oak-grassland, desert scrub, mesquite-cholla, ash-sycamore-cottonwood, juniper, juniper-agave-yucca, oak, pine-oak, pine woodlands; (800–)1000–1700(–2200) m; Ariz., N.Mex.; Mexico (Chihuahua, Sonora).

Verbena xylopoda is distinctive among its close relatives in its (a) stem vestiture—the hispid to hispidulous covering of short, stiffly spreading hairs like a bed of glassy tack points, (b) leaf distribution and morphology—mostly basal and proximal cauline, these often deciduous by flower and fruit, pinnatifid to deeply pinnately toothed, the cauline becoming linear and much smaller, and (c) medium-sized flowers. Especially in Chihuahua, the basal and lower cauline leaves usually have been shed by flower and fruit (when most collections are made), with the inconspicuous cauline leaves remaining persistent, giving the whole plant essentially a leafless appearance.

The population system in Chihuahua might justifiably be recognized as a distinct taxon. The cauline hairs are reduced in size to such an extent that the stems can be characterized as hispidulous-scabrous with greatly foreshortened, non-glandular hairs.

Additional specimens examined. **USA. ARIZONA. Cochise Co.**: Chiricahua Mts, Rucker Valley, stony slope, 6100 ft, 8 Sep 1941, *Barneby 5151* (NY); 19 mi NE of Douglas, desert grassland, 4000 ft, 17 Apr 1940, *Benson 10299* (ARIZ); Chiricahua Mts, Chiricahua Mine, 6000 ft, 21 Oct 1907, *Blumer 1804* (ARIZ, MO, NY); 7 mi W of Chiricahua, steep rocky slope, 5000 ft, 6 Sep 1944, *Darrow et al. 1322* (ARIZ); jct Dragoon-Johnson road with Benson-Willcox hwy, rocky limestone

slopes, 4500 ft, 26 Jul 1943, *Darrow s.n.* (ARIZ); S end of Chiricahua Mts, Coronado Natl. Forest, Tex Canyon drainage, oak and pinyon, 16 May 1985, *Fletcher 8062* (UNM); 11 km W of Hwy 80 on Rucker Canyon Road, foot of earth/rock talus slope along dry draw, 1650 m, 21 Apr 1976, *Garton 16883* (ARIZ); Huachuca Mts, head of Sycamore Gulch, overgrazed land, 12 Apr 1950, *Goodding 90-50* (ARIZ); Huachuca Mts, Roh Canon, 6 Aug 1909, *Goodding 334* (ARIZ, NY); Huachuca Mts, Ash Canyon, dry slope, 7 Oct 1961, *Goodding 417-61* (ARIZ); Swiss Elm Mts., Jun 1907, *Goodding 2246* (MO, SMU); 6 mi NW of Chiricahua, grasslands, 18 May 1945, *Gould & Pultz 3164* (ARIZ, NY); Swisshelm Mts, Leslie Canyon, desert grassland, 4500 ft, 5 May 1992, *Johnson 1-92* (ARIZ); Chiricahua Mts, Dos Cabesas, 28 May 1881, *Lemmon 219* (ARIZ); Chiricahua Mts, Hospital Canyon, N of Paradise, 3 Jul 1959, *McCormick 941A* (ARIZ); Huachuca Mts, Lower Ash Canyon, ca. 0.5 mi W of Hwy 92, creek bank beneath oaks, ca. 5150 ft, 19 May 1979, *McFarland 160* (ARIZ); Chiricahua Mts,White Tail Canyon, near hilltop, *Quercus*, *Arctostaphylos*, 2 May 1935, *Maguire et al. 1328* (ARIZ); Bisbee, 3 Oct 1892, *Mearns 1013* (NY); Chiricahua Natl. Monument , S-facing rocky slopes N of Stafford Cabin Area, grassland-shrub, 5400 ft, 13 Jul 1975, *Reeves R3428* (NY); Fort Huachuca, ENE of Kino Spring,1.2 mi NNE of the mouth of Blacktail Canyon, oak, 1520 m, 28 Jul 1992, *Schulz & Krohn 2322* (ARIZ); Swisshelm Mts, Leslie Creek Canyon, bottom of slope below roadside monument, near USGS gauging station, under *Fraxinus* and *Salix*, ca. 4200 ft, 8 Jun 1980, *Toolin 783* (ARIZ); Whetstone Mts, Middle Canyon, 22 Sep 1976, *Van Devender & Martin s.n.* (ARIZ); Huachuca Mts, S-facing slope of Ash Canyon, near intersection with Lutz Canyon, 5820 ft, 13 Jul 1973, *Wentworth 1061* (NY); Chiricahua Mts., White Trail Canyon, gravelly slope, under *Quercus* and *Arctostaphylos*, 2 May 1935, *Wiegand et al. 11065* (MO, NY-2 sheets). **Gila Co.**: Tonto Natural Bridge, rock crevices, upper slopes of canyon, 19 May 1935, *Nelson 2018* (MO, NY); 10 mi W of Payson, hillside, pinyon-oak and scattered yellow pine, 4500 ft, 13 Aug 1946, *Parker 6121* (ARIZ); Salt River, rocky slopes, 26 May 1935, *Whitehead 1288* (NY); 5 mi N of El Capitan, gravelly slopes, W exposure under *Quercus* and *Rhus*, 13 May 1935, *Wiegand et al. 11336* (NY-2 sheets). **Maricopa Co.**: Papago Indian Reservation, W Papago, stream banks, 2400 ft, Apr 1937, *Albee s.n.* (UNM); Sand Tank Mts, Goldwater Air Force Range, Bender Spring, 3500 ft, 11 Oct 1995, *Felger 95-437* (ARIZ); Sonoran Desert Natl. Monument, Sand Tank Mts., 730 meters (air) NW of Bender Spring, summit of small peak, 3490 ft, 17 Apr 2001, *Felger 01-371* (ARIZ); Sonoran Desert Natl. Monument, Table Top Mt., summit mesa 4280 ft, beneath *Condalia* among boulders, 17 Jan 2002 [past flr and frt], *Felger 02-52* (ARIZ). **Pima Co.**: Santa Catalina Mts, Pepper Sauce Canyon, 16 Apr 1937, 4500 ft, *Arnold s.n.* (ARIZ, NY); Rincon Peak, Rincon Mts, Posta Quemada Canyon, 20 km SE of the edge of Tucson, 2.5 km WSW of Papago Spring, flood plain of narrow valley, desert scrub, 3620 ft, 17 Apr 2007, *Baker 16509* (ARIZ); Rincon Mts, along the Turkey Creek trail, limestone slope, oak-pine woodland, 4700 ft, 17 Apr 1983, *Bowers R1094* (ARIZ); Rincon Mts, Posta Quemada Canyon, limestone slopes in desert scrub, 3800 ft, 23 Apr 1983, *Bowers R1114* (ARIZ); Organ Pipe Cactus Natl. Monument, Ajo Mts, rocky slopes along Bull Pasture Trail, with *Agave* and *Simmondsia*, 3000 ft, 9 May 1979, *Bowers 1704* (ARIZ); unnamed canyon at N end of Sikort Chuapo Mts, ca 2 mi S of Coffeepot Mt., with *Simmondsia chinensis*, *Cercidium microphyllum*, *Larrea divaricata*, *Lycium* sp., 2700 ft, 22 Apr 1981, *Butterwick 7407* (TEX); Mt. Lemmon road, vicinity of Control Road, live oak, lower pine belt, 6500 ft, *Carter s.n.* (SMU); Organ Pipe Cactus Natl. Monument, Ajo Mts, Bull Pasture, 2315 ft, rocky, shallow soil, 9 Apr 2005, *Felger 05-177* (ARIZ); Organ Pipe Cactus Natl. Monument, Ajo Mts, Bull Pasture, vicinity of weather station, 3170 ft, 10 Apr 2005, *Felger 05-220* (ARIZ); Santa Catalina Mts, Sabino Canyon, rocky sopes, 21 Apr 1922, *Hanson 1130* (NY); Baboquivari Mts, 26 Sep 1927, *Harrison 4778* (ARIZ); Vail, 28 Apr 1966, *Hesselberg s.n.* (ARIZ); SW corner of the Rincon Mts, Posta Quemada Canyon, just below Colossal Cave, 3550 ft, sandy wash bottom, 16 Apr 1973, *Holmgren 6810* (NY); Santa Catalina Mts, Sabino Canyon, 27 Sep 1934, *Kearney & Peebles 10355* (ARIZ); Ajo Mts, Canyon Diablo, 21 Mar 1935, *Kearney & Peebles 10846* (ARIZ); north end of Santa Rita Mts, limestone area, 4800 ft, 26 Jul 1976, *McLaughlin 1130* (ARIZ); northern Santa Rita Mts, limestone bajada, shaded bank of wash, 3900 ft, 5 Apr 1986, *McLaughlin 3304* (ARIZ); Buenos Aires Natl Wildlife Refuge, dense grove of *Salix*

gooddingii along San Luis Wash, 3630 ft, 27 May 1988, *McLaughlin 4649* (ARIZ); 4.9 mi NW of Arivaca, lower slopes of San Luis Mts S of Arivaca Creek, with *Opuntia* and mesquite, 3700 ft, 6 Aug 1988, *McLaughlin 4847* (ARIZ); Helvetia, 4200 ft, 9 Aug 1959, *Martin s.n.* (ARIZ); Santa Rita Mts, vic. of Helvetia, grassland with *Mortonia*, *Fouquieria*, *Agave*, 4000 ft, 9 Sep 1982, *Mittleman 359* (ARIZ); Organ Pipe Cactus Natl. Monument, Ajo Mts, Alamo Canyon, 4 May 1939, *Nichol s.n.* (ARIZ); Santa Catalina Mts, Pepper Sauce Canyon, 6 May 1925, *Nichol s.n.* (ARIZ); Organ Pipe Cactus Natl. Monument, Ajo Mts, S side of Arch Canyon, ca. 3500 ft, 28 Mar 1965, *Niles 551* (ARIZ); Baboquivari Mts, Toros Canyon, 28 Mar 1927, *Peebles et al. 3790* (ARIZ); Baboquivari Mts, Fresnal, 11 Jul 1931, *Peebles 7928* (ARIZ); foothills of the Santa Rita Mountains, 11 May 1884, *Pringle s.n.* (NY-2 sheets); Saguaro Natl. Monument, canyon near Sweetwater Trail, limestone bedrock, 3500 ft, 7 Mar 1989, *Rondeau 89-54* (ARIZ); Altar Valley, 21 Mar 1906, *Spalding s.n.* (ARIZ); Fresnal, 6 Apr 1928, *Thackery 42* (SMU); Rozemont, 10 Sep 1915, *Thornber 8111* (ARIZ); Total Wreck Mts, 7 May 1902, *Thornber s.n.* (ARIZ); Saguaro Natl. Monument, King Canyon, gravel in shady canyon bottom, 3100 ft, 29 Mar 1989, *Van Devender 89-102* (ARIZ); Tucson Mts, Saguaro Natl. Monument, Sweetwater Canyon, stream bottom, 2960 ft, 27 Mar 1993, *Van Devender 93-531* (ARIZ). **Pinal Co.**: 15 mi up Aravaipa Canyon from San Pedro Junction, loam soil along stream, 3400 ft, *Populus* and *Juglans*, 22 Apr 1936, *Anderson 1044* (ARIZ); Sonoran Desert Natl Monument, Table Top Mt., grassy saddle and lower slopes of "northern" peak N of trail terminus, upper desert scrub with *Yucca*, *Canotia*, *Pleuraphis*, 4 Apr 2001, *Felger 01-304* (ARIZ); hills above Rosemont, 13 Mar-23 Apr 1903, *Griffiths 4122* (MO); Devil's Canyon above Superior, 28 Mar 1926, *Harrison & Kearney 1488* (ARIZ); Oracle, 20 Apr 1930, *Harrison & Kearney 6689* (NY); 8.1 mi S of Oracle on road to Mt. Lemmon , rocky outcrop with *Fouquieria*, 27 Apr 1973, *Lehto et al. 11033* (NY); 5 mi N of Oracle, along San Pedro River, gravelly W slopes, mesquite and cholla, 20 Apr 1935, *Maguire 10884* (MO, NY-2 sheets); Oracle, 27 May 1973, *Neff 41* (TEX); Santa Catalina Mts, Oracle Road, above road 6.5 mi below turnoff, open slope in grassland, 11 Oct 1962, *Niering & Whittaker s.n.* (ARIZ); Gila River bottom near Sacaton, 30 Apr 1926, *Peebles et al. 1753* (ARIZ); Sacaton Diversion Dam, river bottom, 14 Apr 1926, *Peebles & Harrison 1649* (ARIZ); Sycamore Canyon, upper fork of Virgus Canyon, 8 mi W of Aravaipa Creek, oak woodland, 4800 ft,12 May 1980, *Warren & Anderson 300* (ARIZ); Santa Catalina Mts, Bonito Canyon, ca. 6 mi SSE of Oracle, oak woodland, 4900 ft, 5 May 1979, *Van Devender s.n.* (ARIZ). **Santa Cruz Co.**: Coronado Natl. Forest, Rock Corral Springs, ca. 5.6 km W of I-19 on Rd 4145, *Prosopis-Quercus*, 19 Apr 1995, *Annable 2390* (ARIZ, NY); Fresno Canyon, side drainage E of wash, juniper, 1130 m, 1 Sep 2000, *McLaughlin 8478* (ARIZ); Canelo Hills, Monkey Spring, 4650 ft, pockets on travertine dike, 9 May 1966, *Niles 759* (ARIZ); Ted Knipe property, ca 3 mi W of Sonoita on Rte 82, N end of Canelo Hills, scattered oaks, 4500 ft, 22 Aug 1974, *Reeves R1131* (NY); N side of limestone hill above Papago Springs Cave, 29 Sep 1979, *Toolin 494* (ARIZ). **Yavapai Co.**: Antelope Creek in the Weaver Mts., occasional along creek in riparian, 3800 ft, 6 Apr 1980, *Butterwick & Hillyard 5982* (ARIZ); along jeep trail to Beehive Mine, southern Weaver Mts., 3600 ft, chaparral-desert scrub, oak-*Yucca-Ceanothus*, 1 Jun 1980, *Butterwick & Hillyard 6683* (ARIZ); Rio Verde, Fort Whipple, rocky hills, 8 Sep 1865, *Cones & Palmer 577* (MO); ca. ½ mi E of Jerome, rocky slope, 4500 ft, 14 Apr 1960, *Crosswhite 718* (NY); 1 mi S of entrance to 6Bar Ranch on road between Seven Springs and Bloody Basin, steep chaparral-covered slope, 27 Apr 1974, *Engard et al. 202* (NY); hills on E side of Black Mts, W of Hy 93, NW facing slope, *Cercidium*, *Opuntia*, 2950 ft, *Fischer 6291* (ARIZ); 6 mi NW of Date, open rocky slopes, 3800 ft, 9 Apr 1947, *Gould & Darrow 4180* (ARIZ); 4.7 mi S of Bloody Basin Road, along Seven Springs Rd , N of Magazine Mesa, ca. 3000 ft, chaparral, locally common in rocky wash, 21 Apr 1984, *Hodgson 2832* (NY); Hillside-Congress road, 3.2 mi S of Hillside, 3800 ft, shrubby hillside, 6 May 1973, *Holmgren 7122* (NY); Skull Valley, 4300 ft, 28 Apr 1903, *Jones s.n.* (MO); Copper Basin, 11 Apr 1910, *Lewis 956* (LL). **County unknown**: without locality, 1891, *MacDougal 634* (TEX). **NEW MEXICO. Hidalgo Co.**: Guadalupe Canyon, 15 mi E of jct with road to Douglas, Arizona, very SW corner of the state, *Juniper-Agave-Yucca* zone, dry sandy slope, 4200 ft, 20 Apr 1968, *Hess 1735* (ARIZ, SMU); Guadalupe Canyon, ca. 25 mi E of Douglas, Ariz., dry

hillsides above *Fraxinus-Platanus-Populus* bottomland, rocky areas on slope, 4200 ft, 17 Aug 1971, *Hess 2790* (SMU). **MEXICO. CHIHUAHUA.** 20 mi S of Parral on Hwy 45, open rocky hillsides in oak-grassland, 5900 ft, 28 Jul 1975, *Engard 639* (LL); Mpio. Chihuahua: Rancho La Campana, potreros del plan, 1540 m, pastizal mediano abierto, *Gonzalez E. 855* (TEX); La Campana Experimental Ranch, near Encinillas, 1 Aug 1957, *Knobloch 252* (LL); Encinillas, Hwy 45, 2 Oct 1958, *Jones 23255* (TEX); ca. 50 mi NW from Chihuahua, roadside, 6 Jul 1946, *Lee 46* (NY, TEX); SW of Chihuahua, 1 Aug 1936, *LeSueur 875* (TEX); W of Buenaventura along Hwy 28, 7.4 mi W of jct Hwy 10 in Buenaventura, ravine slope into seasonal spring below road, *Quercus*, 2000 m, 29 Aug 1989, *Mayfield 106* (ARIZ, TEX); 6.4 mi W of jct Hwy 28 with Hwy 10 on Hwy 28 W of Buenaventura, disturbed soil of roadside, 1850 m, 29 Aug 1989, *Mayfield 126* (TEX); vicinity of Chihuahua, ca. 1300 m, 8-27 Apr 1908, *Palmer 52* (NY); vicinity of Chihuahua, ca. 1300 m, 5-10 Jun 1908, *Palmer 360* (MO); Hwy 45, ca 18 mi N of Chihuahua, N side of small mountain range on brownish igneous rock outcrop, overgrazed arid grassland with *Mimosa*, 29 Apr 1985, *Spellenberg et al. 8131* (BRIT, NY); 2 mi up gravel road from Parral-Santa Barbara hwy ca. 2-3 mi W of Parral, 18 Aug 1967, *Stuessy 1013* (NY, TEX); 12.6 mi S of Gallego along Hwy 45, rocky soils, *Mimosa*, 5300 ft, 18 Jul 1975, *Wallace et al. 197* (LL, MO). **SONORA.** Valle de Teras, region of the Rio de Bavispe, [just E of La Angostura], grassland, 28 Aug 1940, *Phillips 753* (ARIZ, LL); 45 km E of Agua Prieta, Rancho Puerta Blanca, 9 Apr 2005, *Roulston SBV141551* (TEX); Fronteras, Jun 1854, *Thurber 446* (NY); NE of Sierra Anibacachi, Rancho La Calera, ca 10 km (by air) SW of Agua Prieta, isolated hill, Chihuahuan desert scrub on limestone, 1287 m, 17 Aug 2007, *Van Devender 2007-842* (TEX); 6 mi E of Agua Prieta, road to Colonia Morelos, region of the Rio de Bavispe, 3900 ft, 7 Aug 1941, *White 3836* (ARIZ, NY); 5 mi N of Fronteras, Hacienda de San Rafael, region of the Rio de Bavispe, mesquite-grassland, 3800 ft, 9-12 Aug 1941, *White 3882* (ARIZ).

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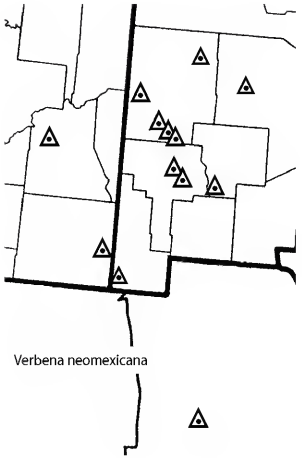
Figure 1. Holotype of *Verbena calinfera* Nesom (*Moran 21749*, LL).

Figure 2. Holotype of *Verbena falcata* Nesom (*Hinton 28113*, MEXU).

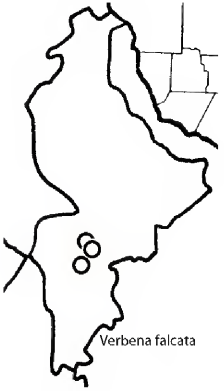
Figure 3. Holotype of *Verbena livermorensis* Turner & Nesom (*Palmer 30791*, TEX). .

Figure 4. Holotype of *Verbena moranii* Nesom (*Moran 24936*, LL). .

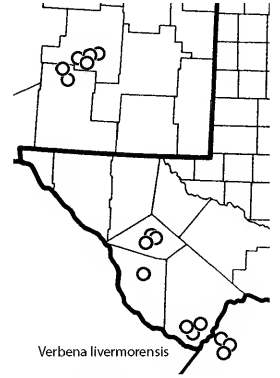


Map 1. *Verbena neomexicana* Small.

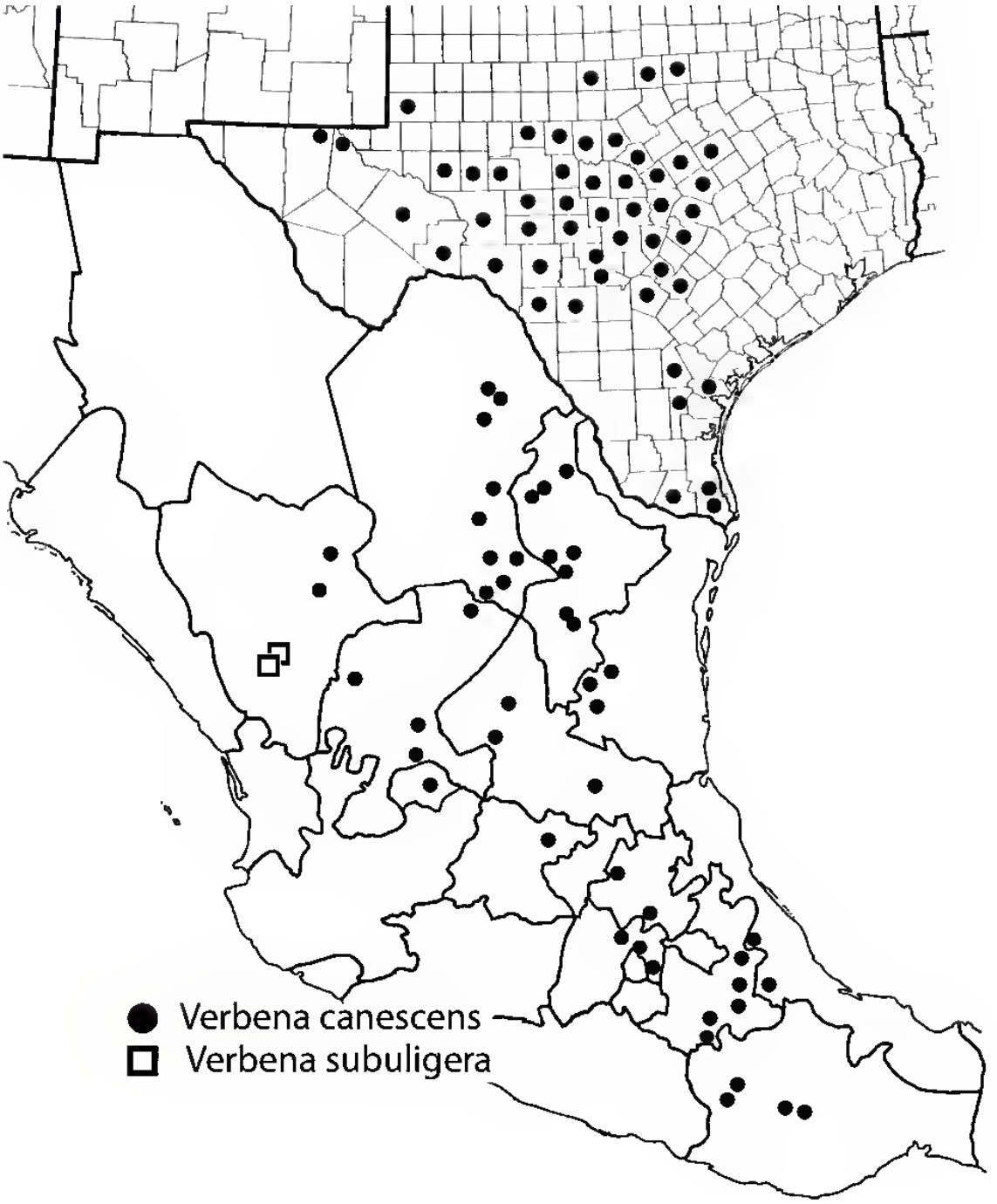
Map 2. *Verbena calinfera* Nesom and *Verbena moranii* Nesom.



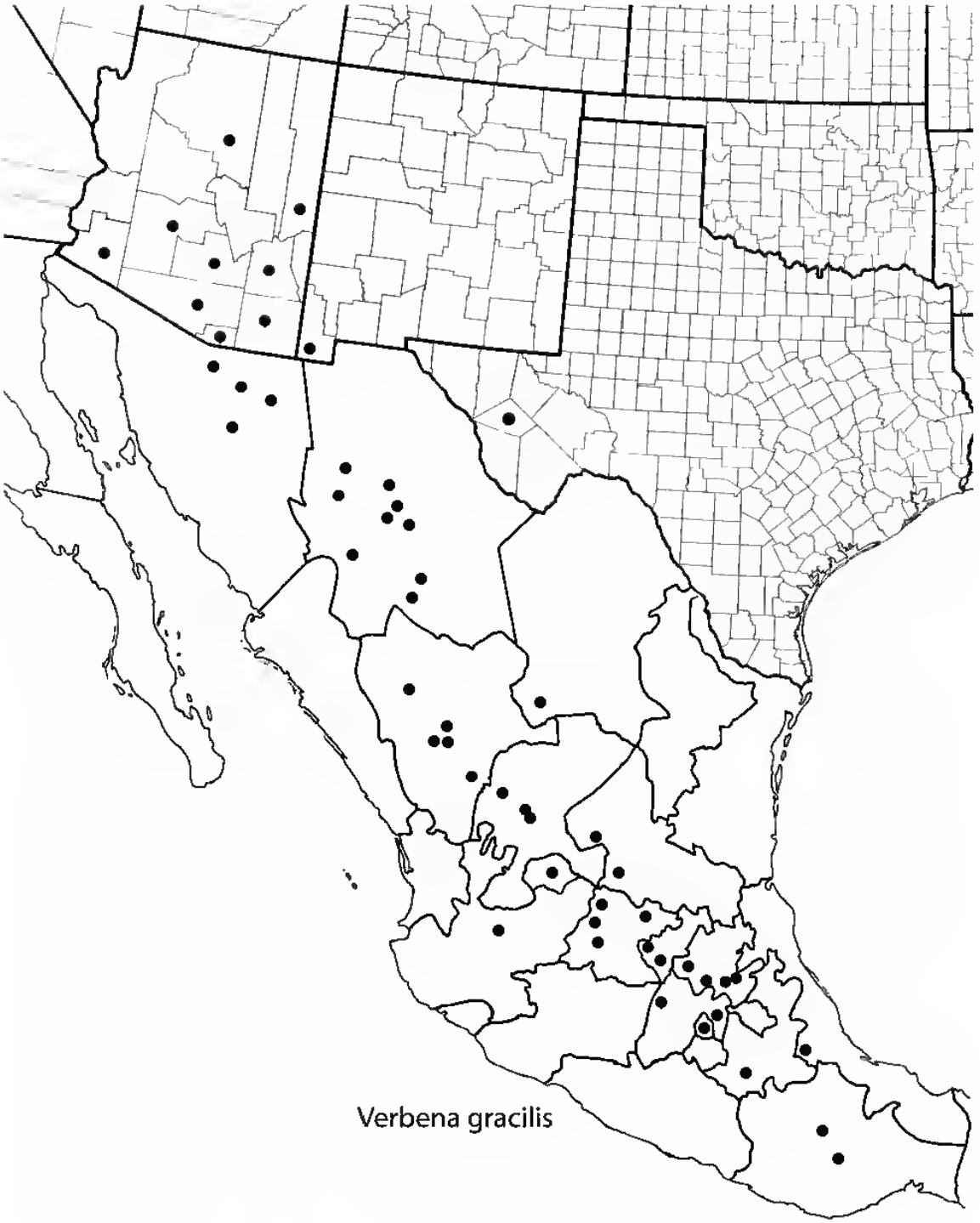
Map 3. *Verbena falcata* Nesom



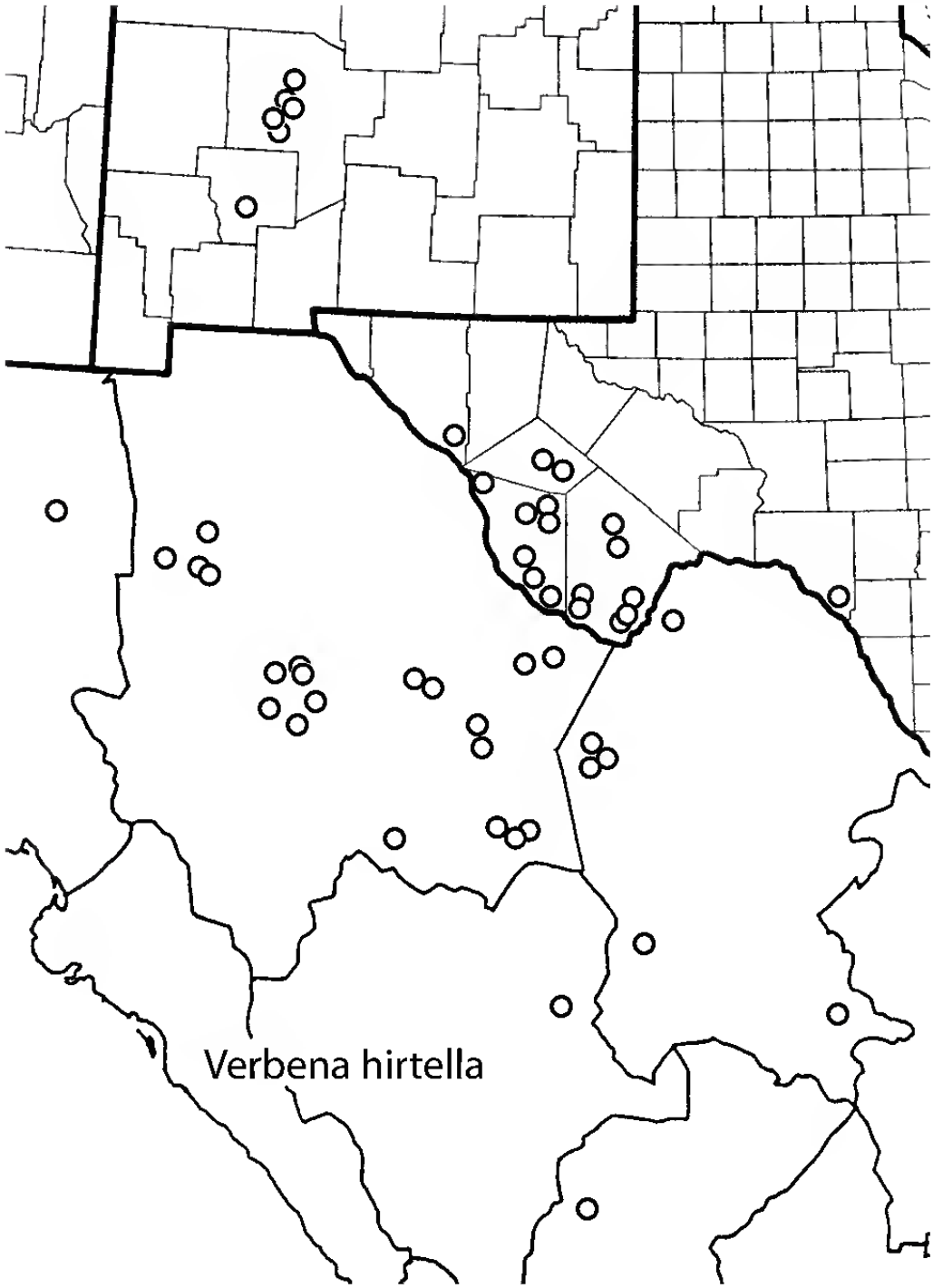
Map 4. *Verbena livermorensis* Turner & Nesom.



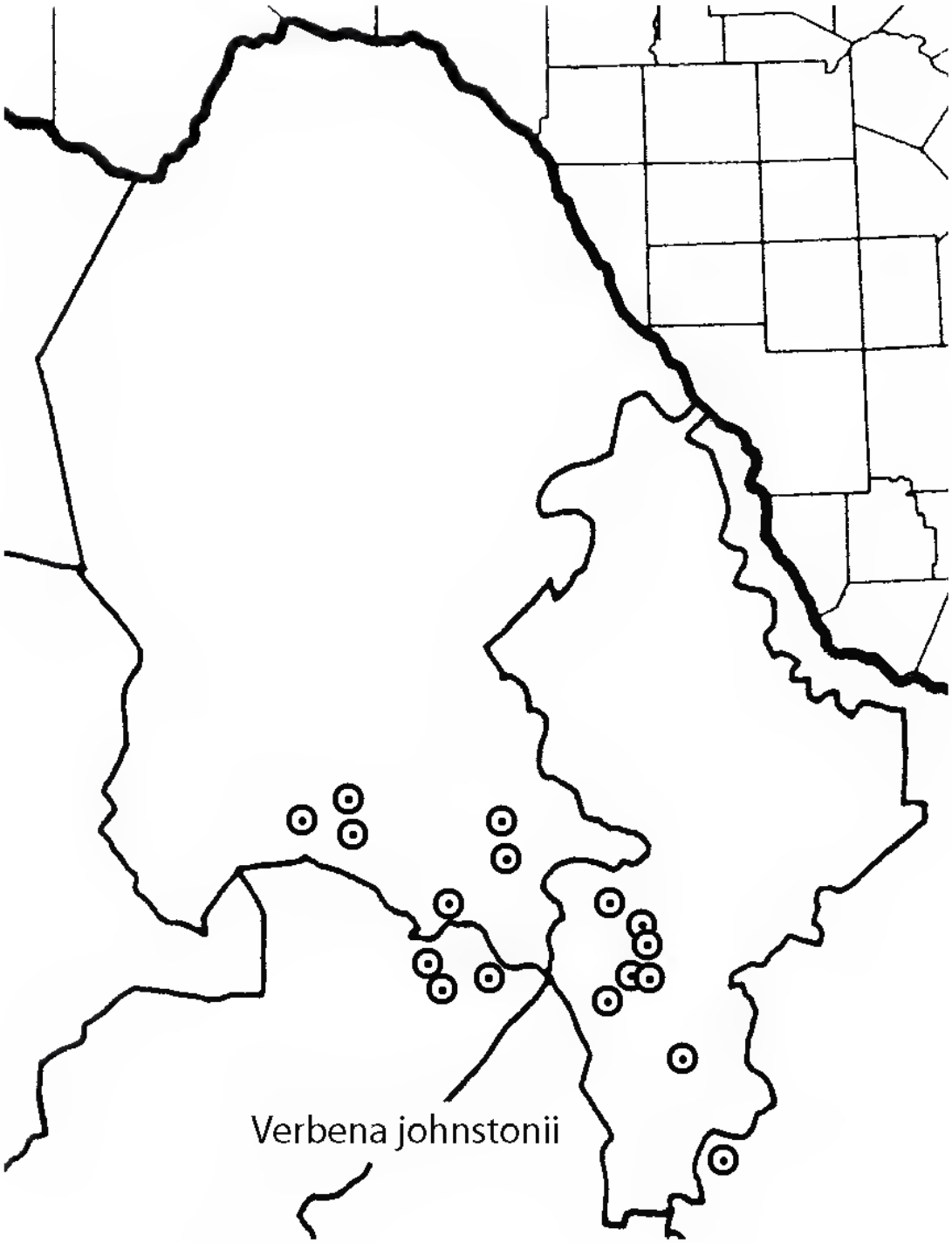
Map 5. *Verbena canescens* Kunth and *Verbena subuligera* Greene.



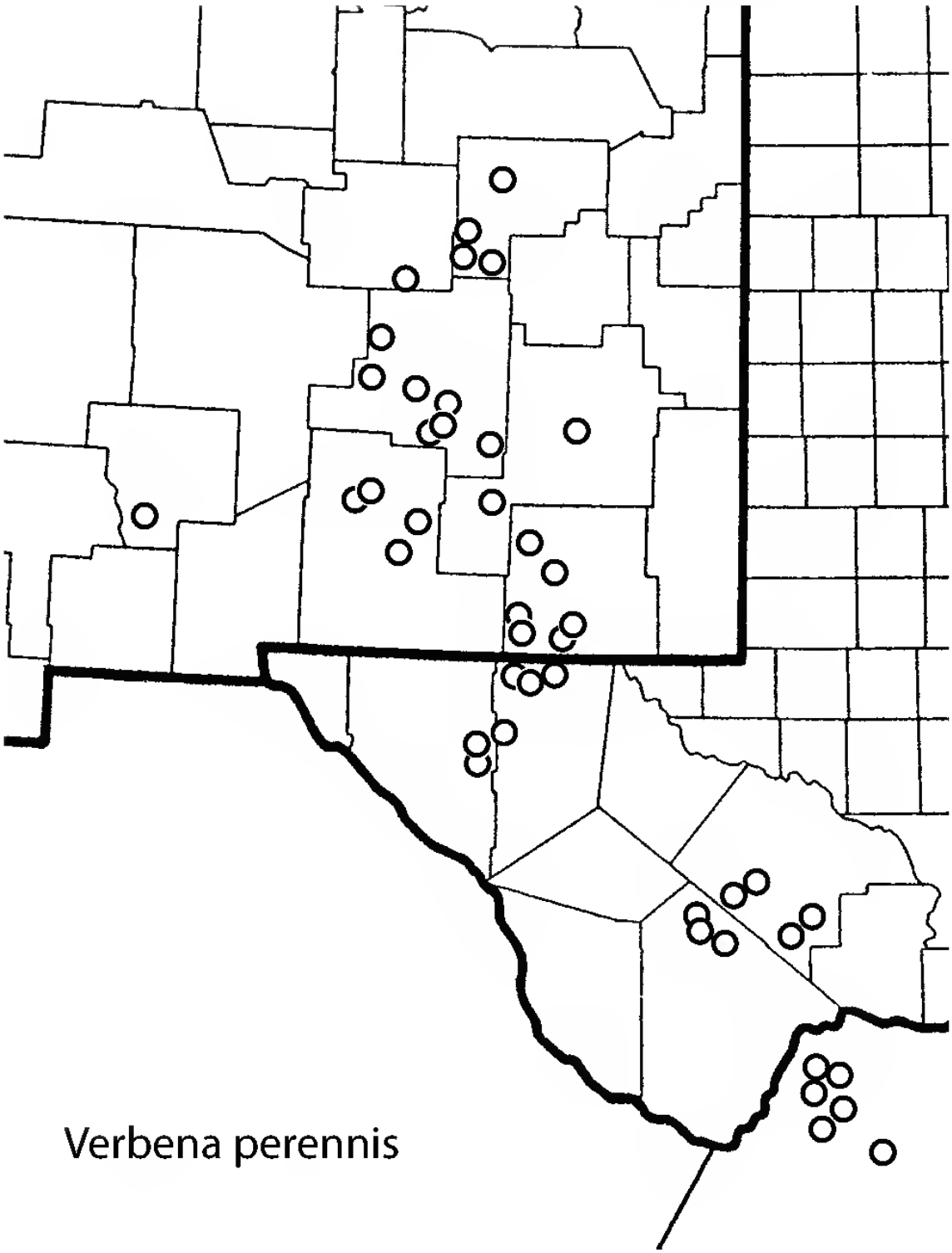
Map 6. *Verbena gracilis* Kunth



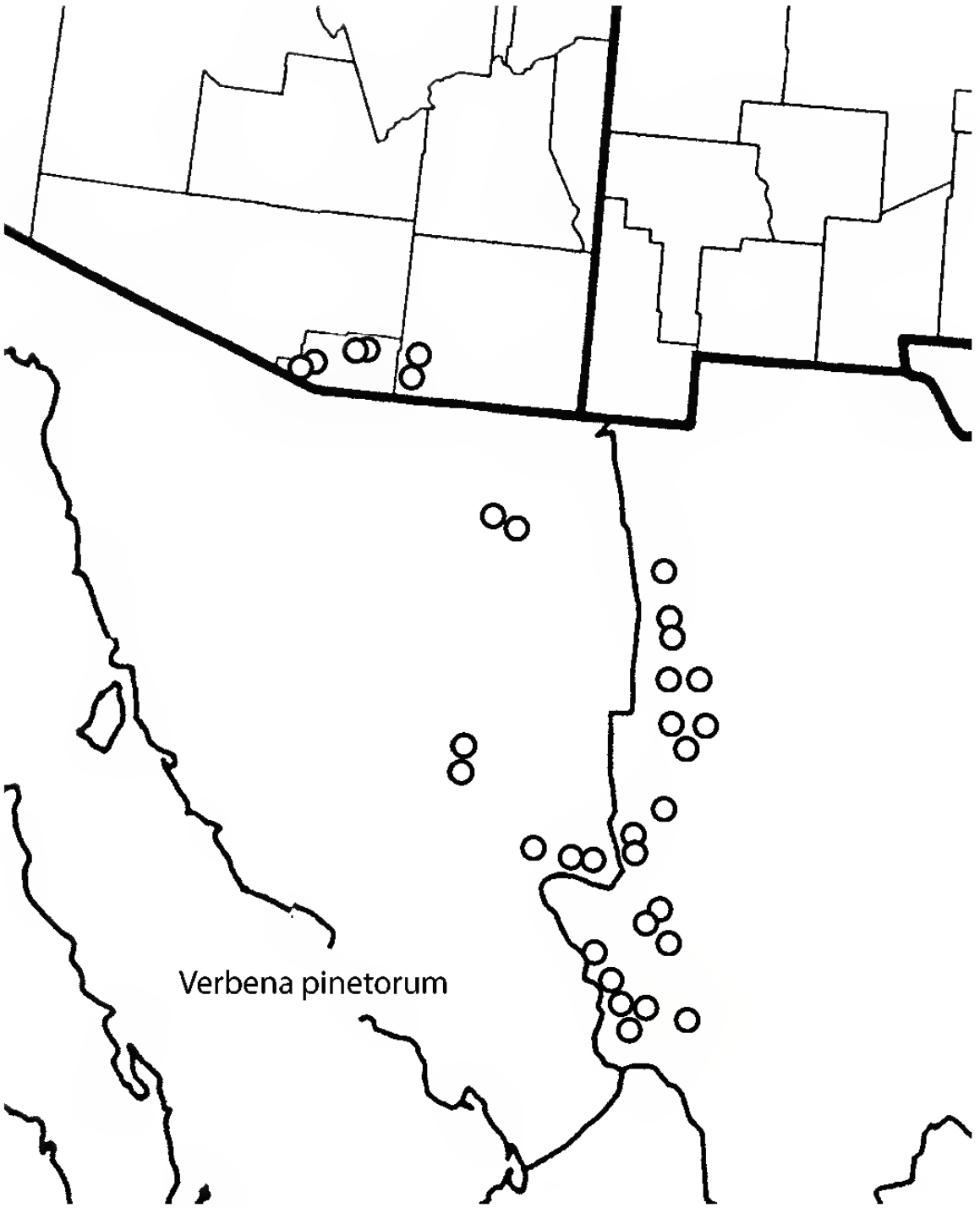
Map 7. *Verbena hirtella* (Perry) Nesom



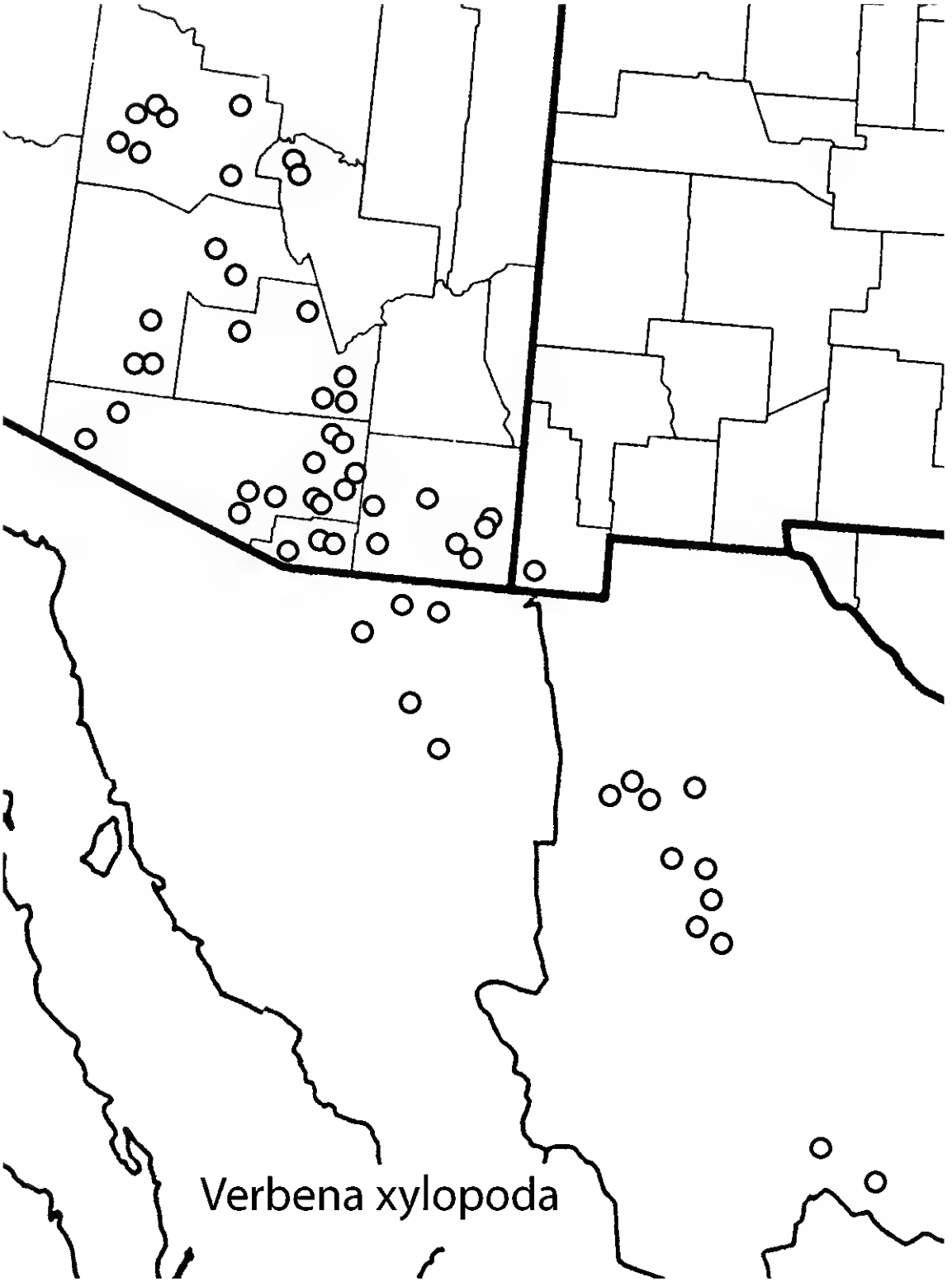
Map 8. *Verbena johnstonii* (Moldenke) Nesom.



Map 9. *Verbena perennis* Wooton.



Map 10. *Verbena pinetorum* Moldenke



Map 11. *Verbena xylopoda* (Perry) Nesom

NOTES ON *ERIGERON VICINUS* (ASTERACEAE: ASTEREAE), A RARE SPECIES IN TEXAS

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ABSTRACT

Erigeron vicinus Nesom is documented by collections from Brewster Co. and Jeff Davis Co., Texas. It was described from populations in the Sierra Madera del Carmen of Coahuila, Mexico, and previously known from the USA only by the collection from Jeff Davis Co., Texas. A distribution map of known localities for the species and color photos of the collections from Texas and Mexico are provided

KEY WORDS: *Erigeron vicinus*, Astereae, rare species, Texas, Coahuila, Mexico

Erigeron vicinus Nesom was described from populations in the Sierra Madera del Carmen of Coahuila, Mexico (Nesom 1990), where it was first thought to be endemic. A collection from the Davis Mountains in Jeff Davis Co., Texas, was discovered later and was the basis for inclusion of the species in the FNANM account (Nesom 2006). A second collection from Texas has been encountered, as cited and mapped here (Fig. 1).

USA. Texas. Brewster Co.: Big Bend National Park, Chisos Mountains, along Juniper Canyon Hiking Trail on the "Basin" side, common in oak-juniper-pine woodland, 20 May 1985, *Porter 1166* (SJNM). **Jeff Davis Co.**: in seepage, up Madera Canyon, on north slope and summit of Mt. Livermore, 20 Sep 1966, *Correll 33741* (LL). Figs. 2–4.

Erigeron vicinus is recognized by a fibrous-rooted, rhizomatous habit (caudices with rhizomelike, relatively slender, lignescent, basal offsets 1–7 cm) and simple or few-branched stems, spatulate and long petiolate basal leaves, and heads on relatively long peduncles. The stems are finely and loosely strigose distally and pilose proximally with spreading-deflexed hairs, completely eglandular. The holotype at TEX (TEX-LL Type Database and Images 2010) clearly shows several basal rosettes connected by rhizomes (or basal offsets) to a central point.

Fryxell 2724 from Coahuila (Fig. 5) is typical in morphology for *Erigeron vicinus* and regularly shaped and filled pollen indicates that it is diploid. The Brewster Co. collection also is typical in morphology. Abortive pollen of the Jeff Davis Co. collection (see notes on sheet) indicates that it probably was polyploid. The tall stems with linear proximal cauline leaves are similar to *E. modestus* A. Gray, which is common in the area and perhaps contributed a genome to the plant.

Erigeron vicinus was not included in the account of rare species in Texas (Poole et al. 2007), but with only two known occurrences in Texas (S1) and 6–20 global occurences (G2), it apparently is equivalent in status to others characterized as rare in Texas.

Erigeron vicinus Nesom, Phytologia 69: 256. 1990. **TYPE: Mexico. Coahuila**. Mpio. Ocampo, Sierra Madera del Carmen, logging road ca 1 km past Campo 4 in mesic forest, ca. 2500 m, 15 Apr 1976, *D. Riskind & T. Patterson 1988* (holotype: TEX!; isotypes: MEXU, TEX!). Digital image of holotype: http://129.116.69.198.427/pics/ready/00373583.JPG.

Perennials, 10–30 cm; rhizomatous, fibrous-rooted, caudices with rhizomelike, relatively slender, lignescent, basal offsets 1–7 cm. **Stems** ascending, branched at or below midstems, pilose on proximal 1/3, hairs spreading-deflexed, loosely strigose distally, eglandular. **Leaves** basal, usually persistent, and cauline, basal blades lanceolate to oblanceolate or narrowly obovate, 10–30 × 3–10 mm, cauline little reduced distally, margins entire or with 1–2 pairs of teeth, loosely strigose with ascending hairs, eglandular. **Heads** 1(–2) on branches from or proximal to midstem. **Involucres** 4–5 × 7–10 mm. **Phyllaries** in 2–3 series, sparsely hirsute, sparsely minutely glandular. **Ray florets** 60–95; corollas white, with lilac abaxial midstripe, 7–10 mm, laminae not coiling or reflexing. **Disc corollas** 1.8–2.2 mm, throats slightly indurate or inflated. **Cypselae** 0.6–0.8 mm, 2-nerved, faces sparsely strigose. **Pappus**: outer of scales, inner of 8–11 bristles.

ACKNOWLEDGEMENTS

I'm grateful to Ken Heil at SJNM (Farmington, New Mexico) for his hospitality while studying in the herbarium there and to Tom Wendt for providing photos of TEX specimens.

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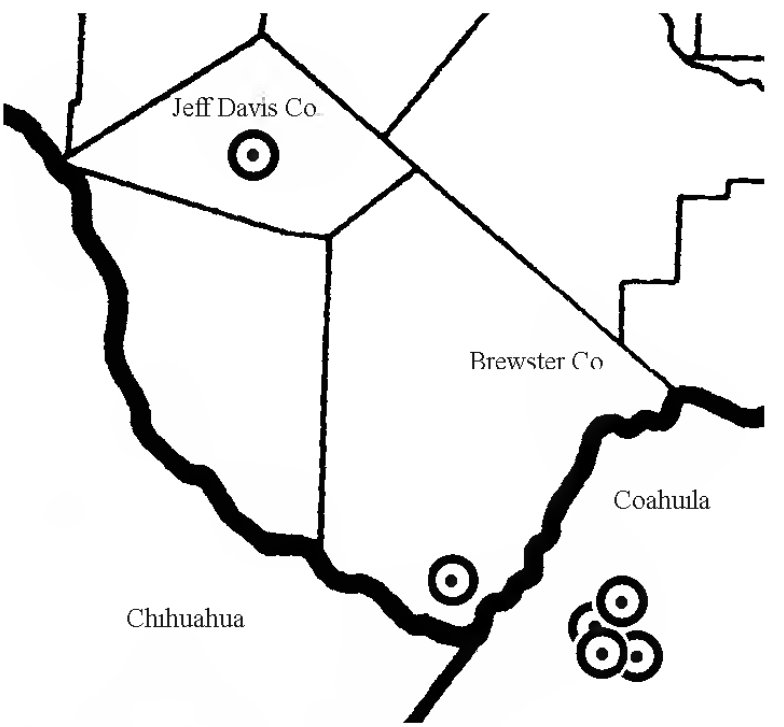

Figure 1. Distribution of *Erigeron vicinus*.

Figure 2. *Erigeron vicinus* from Brewster County, Texas (*Porter 1166*).

Figure 3. Close-up of plants from *Porter 1166*

Figure 4. *Erigeron vicinus* from Jeff Davis County, Texas (*Correll 33741*).

Figure 5. *Erigeron vicinus* from the Sierra Madera del Carmen in Coahuila, Mexico (*Fryxell 2724*).

Nesom, G.L. 2010. Taxonomic status of *Fraxinus coriacea* (Oleaceae). Phytoneuron 2010-37: 1–9. Mailed 1 September 2010.

TAXONOMIC STATUS OF *FRAXINUS CORIACEA* (OLEACEAE)

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ABSTRACT

Fraxinus coriacea has been treated as a variety of *F. latifolia* (= *F. oregona*) and of *F. velutina*. Its geographic range is essentially intermediate (in southern California, Nevada, southwestern Utah, northwestern Arizona) between the two others. Intermediates apparently occur with each of the latter but *F. coriacea* can be recognized as a distinct entity on the basis of its morphology and geography and each is treated here at specific rank. Maps show the county-level distribution for each of the three and the detailed distributions of *F. latifolia* and *F. coriacea*. A lectotype is designated for *F. oregona* var. *glabra*.
KEY WORDS: *Fraxinus coriacea*, *F. velutina*, *F. latifolia*, taxonomy

Trees identified as *Fraxinus coriacea* S. Wats. (1873) from the southwestern USA have had an inconsistent taxonomic history. Sargent (1894) included *F. coriacea* in the synonymy of *F. velutina* but later (1902, p. 33) treated it as a distinct species and included Faxon's line drawing of it (reproduced here as Fig. 1). "In the sixth volume of this work [Silva of North America] *Fraxinus coriacea* was considered a form of *Fraxinus velutina*. It differs from that species in its fewer longer-stalked leaflets which are more coriaceous and more coarsely serrate, and in its range, *Fraxinus coriacea* being a tree of the mesas and low plains, while *Fraxinus velutina* is an inhabitant of mountain cañons; and with our still slight knowledge of the southwestern species of *Fraxinus* it is perhaps best to consider it a species." Still later, Sargent (1922) treated the southern California trees as *F. oregona* var. *glabra*, not recognizing *F. coriacea* even as a synonym: "the var. *glabra* in Los Angeles and San Bernadino Counties, and east of the Sierra Nevada in Inyo County (Ash Creek near Owens Lake), and occasionally northward in California."

Rehder (1917) apparently was the first to formally associate *Fraxinus coriacea* with *F. velutina*, treating it as *F. velutina* var. *coriacea* (S. Wats.) Rehder. Munz and Laudermilk (1949) observed that var. *coriacea* "is a recognizable variety of *F. velutina* with enough characters and distinct range, *F. velutina* itself not being known from California." They also (1949, p. 60) noted that "Rehder's *F. oregona* var. *glabra*, on the basis of plants so identified and of characters used and range given, seems to be a synonym of *F. velutina* var. *coriacea* as treated by Jepson (Fl. Calif. 3: 80, 1939)." *Fraxinus velutina* var. *coriacea* has been recognized by Lingelsheim (1920), Jepson (1939), Abrams (1951), Munz and Keck (1959), Shreve and Wiggins (1964), and Wiggins (1980).

Miller (1955) treated both *Fraxinus velutina* and *F. latifolia* as subspecies within her extremely broad concept of *Fraxinus pennsylvanica* and recognized *F. coriacea* simply as a synonym of *F. velutina*. Holmgren (1984) also included *F. coriacea* simply as a synonym of *F. velutina*, as did Wilken (1993), who recognized *F. velutina* as widely distributed in southern California and noted that it apparently hybridizes with *F. latifolia*. Wallander (2008) did not consider *F. coriacea* even as a synonym.

Among those who have recognized *Fraxinus coriacea* as a distinct entity, descriptions of its diagnostic features have been relatively consistent, and the present study also is in agreement. These trees are characterized by thick leaves, usually glossy above, typically broadly obovate and distally

serrate, often with minutely apiculate teeth. The lateral veins are prominent and slightly raised, 6–9(–13) on each side, arching upward, conspicuously parallel and running nearly to the margin before branching. A raised reticulum of smaller veins is prominent on both surfaces. The minute peltate scales on the leaflet abaxial surfaces appear to be slightly sunken into the epidermal surface. As noted by Munz and Laudermilk (1949) leaf vestiture varies from glabrous to hirtellous on both surfaces. They also found that *F. coriacea* differs from *F. latifolia* in microsculpturing of the abaxial leaflet surfaces — it differs in microsculpturing from *F. velutina* as well but less so than from *F. latifolia*.

Munz and Laudermilk (1949) noted that intermediates occur between *Fraxinus coriacea* and *F. latifolia*, especially in Tulare County, at the northern end of the range of *F. coriacea* and, according to them, at the southern extremity of *F. latifolia*. Owston's map (1990; reproduced as Fig. 5 in the present study) showed *F. latifolia* reaching slightly further south into northern Kern County, and Little (1971) mapped *F. latifolia* with a disjunct southern segment reaching through Ventura, Los Angeles, and San Bernadino counties.

Observations in the present study also indicate that *Fraxinus latifolia* sensu stricto reaches the southern counties of California, although uncommon there, where it may account for some of the variability in *F. coriacea*. The distinctive, stiffly curving, partially reclining foliar hairs (abaxial surfaces) of *F. latifolia* never occur in *F. coriacea* but are abudantly produced by plants of the following collections. **Los Angeles Co.**: La Tuna Canyon, Verdugo Hills, sandy wash, 26 Mar 1933, *MacF s.n.* (NY). **Riverside Co.**: southern Santa Ana Mts., San Mateo Canyon Wilderness Area, along San Mateo Creek from Riverside Co. line, following San Mateo Trail upstream to confluence with Bluewater Canyon, riparian, 800-100 ft, 23 Apr 1992, *Boyd 7068* (NY). **San Diego Co.**: Hot Springs, Jun 1880, *Vasey 365* (NY); Cleveland Natl. Forest, Trabuco District, Rd 7504 at jct with Alamos Canyon Creek, riparian habitat in chaparral, 200 m, 8 Mar 1995, *Walker 1236* (NY); along Cottonwood Creek, 2.3 mi above Barrett Store, on road to Barrett Dam, 1100 ft, 28 Oct 1940, *C.B. Wolf s.n.* (TEX; this specimen from a cultivated tree in RSA Botanic Garden, grown from the original collection by Wolf).

In summary and conclusion, *Fraxinus coriacea* has been consistently recognized as a distinct entity in studies with a broader purview, although it has sometimes been treated as an element within *F. velutina*. The current study further confirms its apparent morphological and geographical reality. In view of its discrete geographical range and intermediate position between *F. velutina* and *F. latifolia*, hybridization and intermediacy between these two and *F. coriacea* probably is less common than previously suspected. In fact, given its allopatric distribution, *F. coriacea* seems relatively simply to identify and treatment at specific rank appears to be justified.

Fraxinus coriacea and *F. latifolia* can be distinguished by the following contrasts.

1. Leaflets relatively thick, venation distinctly raised on both surfaces, blades mostly obovate, glabrous or hirtellous with straight, erect hairs, margins toothed on distal 1/2–1/3 to entire; lateral petiolules 5–10(–13) mm ..... **Fraxinus coriacea**
1. Leaflets relatively thin to thickened, venation not raised, blades mostly oblong elliptic-oblong to oblong-ovate or oblong-obovate, sparsely to densely villous abaxially with stiffly curving, reclining hairs, margins usually entire; lateral petiolules 0(–3) mm ..... **Fraxinus latifolia**

Intermediates also apparently occur between *Fraxinus coriacea* and *F. velutina*, especially in southwestern Utah in the restricted region where there ranges apparently come into contact. Other plants within the range of *F. velutina*, especially in Arizona, sometimes may appear close in

morphology, at least superficially, to *F. coriacea*, but the two distinct geographic elements are clear and the two taxa can be distinguished by the following contrasts.

1. Leaflet blades relatively thick, peltate scales somewhat sunken into abaxial epidermis, venation distinctly raised on both surfaces; lateral petiolules 5–10(–13) mm ..... **Fraxinus coriacea**
1. Leaflet blades relatively thinner, peltate scales superficial on abaxial epidermis, venation not distinctly raised; lateral petiolules 0(–2) mm ..... **Fraxinus velutina**

Fraxinus coriacea S. Wats., Amer. Naturalist 7: 302. 1873. *Fraxinus velutina* var. *coriacea* (S. Wats.) Rehder, Proc. Amer. Acad. Arts 53: 206. 1917. *Fraxinus pistaciifolia* var. *coriacea* (S. Wats.) A. Gray, Syn. Fl. N. Amer. 2(1): 74. 1878. **LECTOTYPE** (Rehder 1917): **USA. Nevada**. [Nye Co.:] Ash Meadows, 1871, *Lieut. Wheeler s.n.* (GH; isolectotype: NY digital image!; probable isolectotype: GH!).

Fraxinus oregona var. *glabra* Lingelsh. ex Rehder, Proc. Amer. Acad. Arts 53: 207. 1917. **LECTOTYPE** (designated here): **USA. California**. [Tulare Co.:] Along creeks, Greenhorn Mountains, 3000–4000 [ft], Apr-Sep 1897, *C.A. Purpus 5555* (US digital image!; isolectotype: UC). Rehder also cited collections by Abrams (San Bernadino Co.) and Abrams & McGregor (Los Angeles Co., San Bernadino Co.). He noted that an attempt by Lingelsheim in 1907 to describe this species resulted in a nomen nudum. Lingelsheim (1920, p. 43) still later treated *F. oregona* "Var. β glabra nov. var. Lingelsh." citing "(Parish n. 540!, Wright!). — Scheint auf Californien beschrankt zu sein. — In Kultur noch selten."

Trees 5–10 m; twigs terete; bark light gray; winter buds brown. **Leaves** deciduous, pinnately compound, 6–15(–20) cm, leaflets (3–)5(–7, rarely), yellow-green on both surfaces, glossy adaxially, glabrous to sparsely to moderately hirtellous on both surfaces, not papillose, blades (2–)3–10 cm x 2–5.5 cm, broadly obovate to broadly elliptic-obovate or subrotund, apices obtuse or subtruncate to long-acuminate, base obtuse to acute or acuminate, margins usually shallowly serrate on distal 1/2–2/3 and often with apiculate teeth; petioles 15–35(–55) mm, bases slightly raised, leaf scars thin to thick crescent-shaped, 3–4 mm wide; petiolules 5–10(–13) mm. **Flowers** unisexual (species dioecious), appearing before the leaves, wind-pollinated; pistillate calyx ca. 1 mm, persisting at base of samara; petals absent. **Samaras** 18–32 mm, body plump and subcylindric, wings 2, gradually expanded from near the middle of the body, 4–6 mm wide at the widest point, often notched at the apex. 2n = 46 (Wright 1957), 2n = 92 (Taylor 1945).

Flowering Apr–Jun. Sandy flats, gravelly washes, irrigation ditches, river banks, canyon bottoms, cliff bases, desert shrub, chaparral, digger pine, digger pine-Douglas oak, ash-leaved maple; (700–)800–1700(–2100) m; Ariz., Calif., Nev., Utah. Reported from Baja California (Munz & Keck 1959; Wiggins 1980, "sw flank of the Sierra San Pedro Martir"). Welsh et al. (2003) noted that *F. velutina* occurs in southeastern Iron Co. and western Kane Co. — I have not seen the specimens to document this but they should be examined to confirm their distinction from *F. coriacea*.

Shreve and Wiggins (1964, p. 1087)) noted for *Fraxinus velutina* var. *coriacea* that "A specimen that may belong here was collected in the foothills near the southwest flank of the Sierra San Pedro Martir in Baja California." Wiggins (1980) also cited "sw flanks of Sierra San Pedro Martir" for the taxon.

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Specimens were studied from BRIT-SMU, GH, NY, SJC, TEX-LL, and UNM during visits to those herbaria. I'm grateful to Robert George (BRIT) for help with technical problems and to Néstor D. Pérez-Molière (NY) for the specimen images. This study was done in part under contract for the Flora of North America Association, in conjunction with preparation of the FNANM treatment of *Fraxinus*.

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Figure 1. Line drawing of *Fraxinus coriacea* by Charles Faxon, from Sargent (1902).

Figure 2. Representative specimen of *Fraxinus coriacea* from Nye Co., Nevada (*Roos 6082*, NY).

Figure 3. Details of leaves (Nye Co., Nevada, *Roos 6082*, NY) and fruits (Clark Co., Nevada, *Williams 80-32-J*, NY)

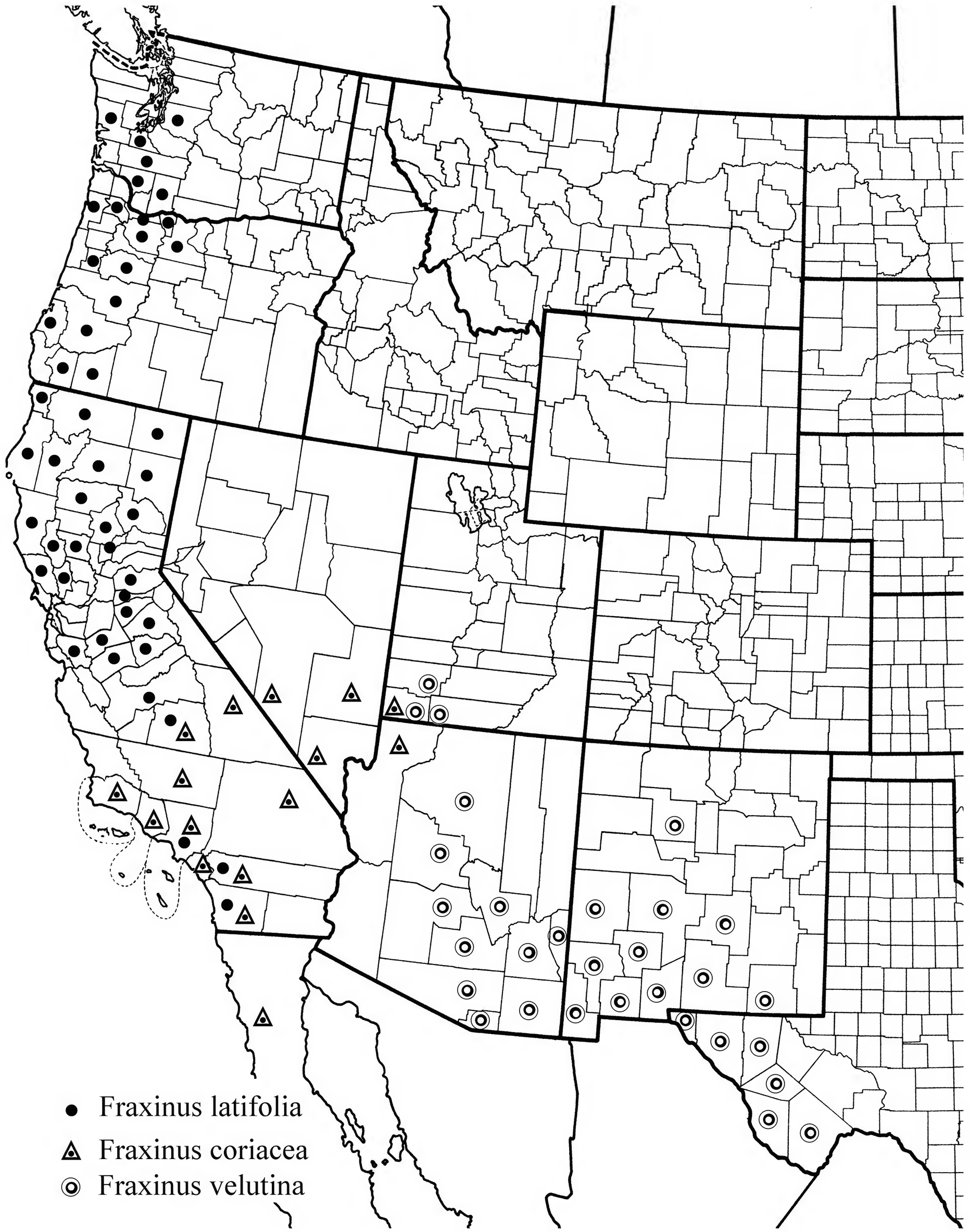

Figure 4. County distributions (native range) of *Fraxinus coriacea*, *F. latifolia*, and *F. velutina*. The range of *F. velutina* extends into Mexico. Welsh et al. (2003) noted that *F. velutina* (? = *Fraxinus coriacea*) also occurs in southeastern Iron Co. and western Kane Co., Utah — symbols in those counties are based on their report.

Figure 5. Native range of *Fraxinus latifolia*, from Owston (1990). The range is extended southward in the present study (see Fig. 4 and text).

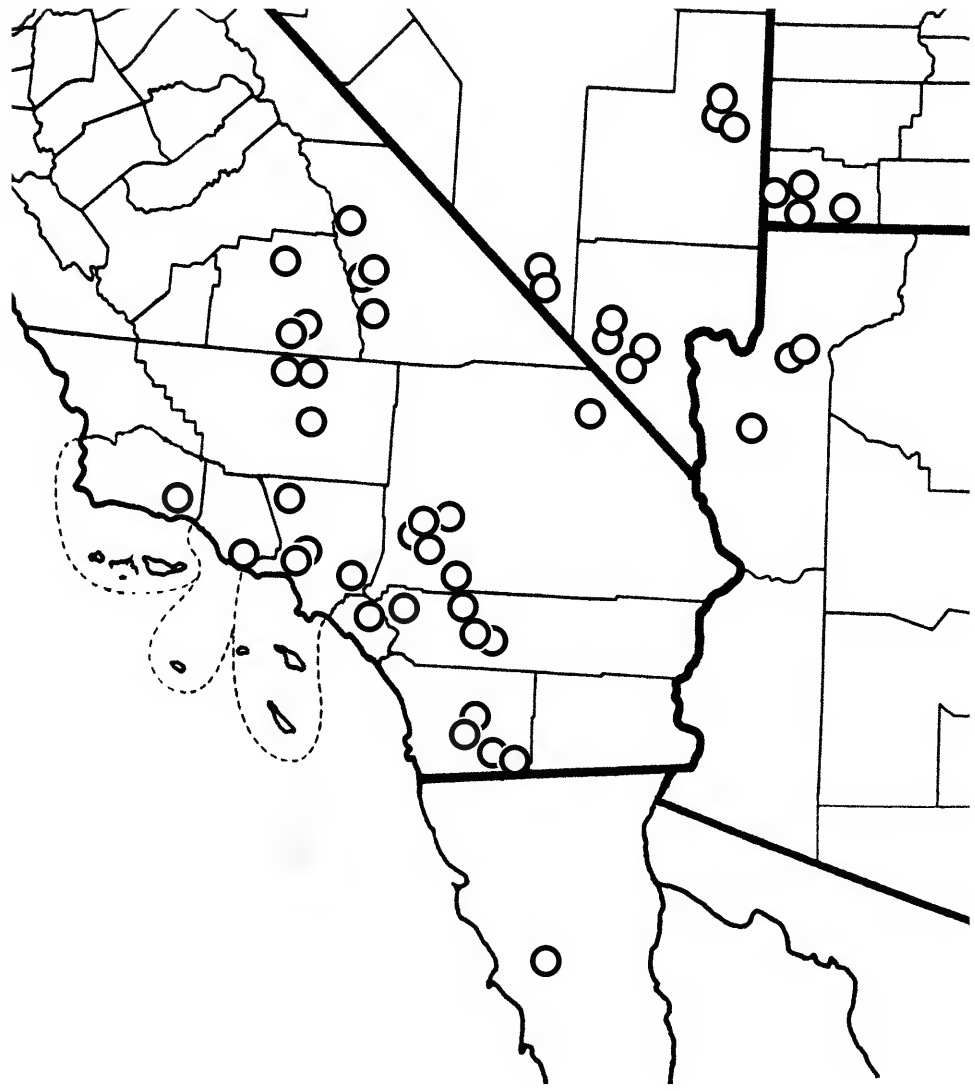

Figure 6. Detailed geographic distribution of *Fraxinus coriacea*. Some localities have been added from Munz and Laudermilk (1949); the symbol for Baja California also is added from literature; see notes in text.

Nesom, G.L. 2010. Notes on *Fraxinus cuspidata* and *F. gooddingii* (Oleaceae). Phytoneuron 2010-38: 1–14. Mailed 1 September 2010.

NOTES ON *FRAXINUS CUSPIDATA* AND *F. GOODDINGII* (OLEACEAE)

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ABSTRACT

Fraxinus cuspidata and *F. macropetala* are distinct in leaf morphology and geography but an area of intermediacy occurs in western New Mexico and the two taxa are treated here as conspecific: *F. cuspidata* Torr. var. *cuspidata* and *F. cuspidata* var. *macropetala* (Eastw.) Sarg. Apparent foliar dimorphism has been documented throughout the range of var. *cuspidata* — the atypical leaves may occur on branches of plants with otherwise typical leaves or entire plants apparently may produce the atypical morphology. Distributions of the two varieties are mapped and lectotypes are designated for *F. cuspidata* and *F. macropetala*. A description with comments and distribution map are provided for *F. gooddingii*.

KEY WORDS: *Fraxinus cuspidata*, *F. macropetala*, *F. gooddingii*, Oleaceae

Fraxinus cuspidata Torr. has been treated to include *macropetala* Eastw. or as a variety (e.g., Kearney & Peebles 1960) or simply as a synonym (e.g., Miller 1955, Holmgren 1984). In the review here, it is observed that the difference is subtle but the two taxa are maintained as weakly differentiated geographic entities.

FRAXINUS CUSPIDATA Torr. in W.H. Emory, Rep. U.S. Mex. Bound. 2(1): 166. 1859. *Ormus cuspidata* (Torr.) Niewl. Amer. Midl. Naturalist 3: 187. 1914. **LECTOTYPE** (designated here): **USA. Texas. [Hudspeth Co.:]** Eagle Mountains and Great Cañon of the Río Grande, [no date], *C.C. Parry s.n.* (NY! digital image!; isolectotype: GH). Rehder (1917, p. 201) referred to this collection but not to the herbarium of deposition. The label of the lectotype has "Fraxinus cuspidata n. sp." apparently in Torrey's hand. The lectotype has only "Parry" as the collector and has no date. The GH sheet apparently notes "C.C. Parry and J.M. Bigelow" as collectors and specifies "21 Jun 1855" as the collection date.

Torrey also cited "No. 1698, Wright:" N.Mex. 1851-1852, *C. Wright 1698* (PH, US digital image!); the three GH sheets of *Wright 1698* note that it was collected in ravines near Eagle Springs, Hudspeth County, Texas. *Parry 1092*, from the "Valley of the Río Grande below Doñana" (NY! digital image!, PH), noted to be a possible type, was not among specimens cited by Torrey.

Trees, (2–)4–7 m; twigs cylindric; bark gray, smooth; winter buds reddish brown. **Leaves** deciduous, pinnate, 4–11 cm, spaced along distal portions of stems; leaflets subcoriaceous to thin, 5–9, glabrous or commonly hispidulous to hirsutulous on both surfaces, scaly-punctate abaxially, not papillose, blades 2.5–8 cm x (5–)1–2.3 cm, narrowly lanceolate to narrowly ovate-lanceolate, apex long-acuminate, base acute to attenuate, margins serrate with teeth drawn out to a filiform, subglandular apex, lateral petiolules 3–10 mm, winged; rachis 10–25 mm, angled and grooved but not winged; petioles 5–30 mm, bases on raised pedestals. **Flowers** bisexual (plants hermaphroditic), appearing before or with leaves, fragrant and insect pollinated; pistillate calyx present and persistent or deciduous at base of samaras; petals 4, white, united in tube 2–3 mm, lobes linear, 5–6 mm. **Samaras** 15–28 mm, body flat, hardly differentiated from wings, wings 2, arising from proximal 1/4–1/2 of body, 5–8 mm wide.

1. Leaflet apices long-acuminate ..... *Fraxinus cuspidata* var. *cuspidata*
1. Leaflet apices abruptly short-acuminate to obtuse ..... *Fraxinus cuspidata* var. *macropetala*

Fraxinus cuspidata var. **cuspidata** Figs. 1–4.

Fraxinus cuspidata var. *serrata* Rehder, Proc. Amer. Acad. Arts 53: 202. 1917. **TYPE: MEXICO. Coahuila**. Mountains E of Saltillo. 15 Apr 1880, *E. Palmer 796* (holotype: GH; isotype: US digital image!).

Flowering Apr–May(–Jul). Dry stream beds, ledges, among boulders, ravines, ledges, ridges, igneous soil, limestone, *Dasylirion-Yucca-Rhus*, acacia-sotol scrub, chaparral, oak-juniper-pine, oak-ash; (800–)1500–2300 m; New Mexico, Texas; Mexico (Chihuahua, Coahuila, Nuevo León, Tamaulipas).

Fraxinus cuspidata var. **macropetala** (Eastw.) Rehder, Proc. Amer. Acad. Arts 53: 201. 1917. Fig. 5. *Fraxinus macropetala* Eastw., Bull. Torrey Bot. Club 30: 494. 1903. *Fraxinus cuspidata* subsp. *macropetala* (Eastw.) E. Murray, Kalmia 12: 20. 1982. **LECTOTYPE** (designated here): **USA. Arizona**. "Yavapai Co." **[Coconino Co.]**: Rim of Grand Cañon of Colorado, "Grand View," 9 Jul 1892, *E.O. Wooton 1102* (CAS digital image!; isolectotype: NY! digital image!, US fide Rehder 1917). Eastwood also cited another collection: **Arizona. Coconino Co.**: Grand Canyon, Colorado River, Bright Angel Trail, 10 May 1903, *C.H. Merriam s.n.* (CAS digital image!).

Flowering Apr–May(–Jul). Dry stream beds, ledges, among boulders, ravines, ledges, chaparral, oak-juniper-pine, oak-ash; 1500–2300 m; Arizona, Nevada, New Mexico.

In the protologue (p. 494), Eastwood noted that "This comes nearest to [*Fraxinus*] *cuspidata* Torr., but differs in the shape of the leaves and the longer fruit which is contracted somewhat at base. The calyx is different and the divisions of the corolla are much longer." Rehder observed (1917, p. 202) that "this variety differs from the type chiefly in its 3-5, rarely 7-foliolate leaves with broader, often ovate, entire leaflets; occasionally with simple leaves at the base of the branchlets. All the other distinguishing characters given in the original description of *F. macropetala* can be found in the typical form." The current study corroborates Rehder's observation that differences between the more western *F. macropetala* and the more eastern *F. cuspidata* are consistent only in leaf morphology.

Unifoliolate leaves commonly are produced in var. *macropetala* but apparently not in the typical variety. As observed by Rehder (1917, p. 202) "On many flowering branchlets all the leaves are simple …; a sterile specimen collected … in the Sycamore Canyon has most of the leaves simple and the others with only one pair of small leaflets at the base."

Vegetative dimorphism in *Fraxinus cuspidata*.

Vegetative dimorphism in *Fraxinus cuspidata* has been a source of confusion for some (initially including the present author) and has led to misidentifications. In fact, the atypical, small-leaved variant has been the basis of previous reports of the occurrence of *F. greggii* in New Mexico (e.g., Martin & Hutchins 1980; USDA, NRCS 2010). The variant is represented in collections by branches with leaves much smaller and differently shaped (Figs. 2–4) than typical of the species. Another unusual variant, apparently, produced obtrullate-obovate leaves rounded and shallowly toothed at the apices (*Palmer 30928*, from Jeff Davis Co., Texas).

Rehder (1917, p. 201) observed that "Shrubs with rather densely pubescent and at the same time smaller and broader leaflets apparently represent merely a juvenile form, as I found such foliage

only on stunted shrubs without fruit; only once I found a slightly pubescent shrub with a few fruits. Pringle has also distributed sterile branches with pubescent leaves under his number 137 from the Santa Eulalia Mountains in Chihuahua" (see Fig. 2).

U.T. Waterfall observed the same phenomenon on collections he made in 1943 from Hudspeth County, Texas: "Note striking dimorphism revealed by #4797 and #4798, both from the same tree." The atypical variant (4798, as cited above) was collected from "lower and inner branches … from [the] same tree as 4797." At nearly the same locality, Rogers McVaugh made a similar collection in documentation of the dimorphism, noting that it occurred on a single tree —his *7357* bears a nearly typical branch and an atypical one, on *7357a* only a large branch with atypical leaf morphology. McVaugh's *8036* from Hudspeth County also explicitly notes that the dimorphism occurs on a single tree.

On the other hand, collections that bear only the typical morphology suggest that it also may be the only form produced by some trees. Further, branches with the variant morphology are not necessarily sterile; for example, *Read A-479* (Culberson Co., Texas; Fig. 3) and *Heil & Clifford 14417* (McKinley Co., New Mexico; Fig. 4) are fertile pistillate branches.

Miller (1955) called attention to Waterfall's #4797 and #4798 (comments above), noting that the variability might be regarded as analogous to the difference between typical *F. cuspidata* and *F. macropetala*, in justification of complete synonymy of the latter. "There is certainly small point in assigning a Latin name at one extreme of a variation when the total range of variation can be found in a single tree." A possible element of homology underlying the similarity between *F. macropetala* and the atypical variants of typical *F. cuspidata* seems plausible. The collection by *Heil & Clifford 14417* (McKinley Co., New Mexico; Fig. 4), which probably is an expression of var. *macropetala*, is comparable to atypical variants of var. *cuspidata*.

Collections examined of the atypical leaf form of *Fraxinus cuspidata*: **New Mexico. Dona Ana Co.**: Feeder Canyon, Upper Ash Canyon, San Andres Mountains, 23 Oct 1975, *Von Loh 741* (UNM), *742* (UNM). **Hidalgo Co.**: Thompson Canyon, Big Hatchet Mts., 19 Aug 1954, *Castetter 9507* (UNM); Thompson Canyon, Big Hatchet Mts., 7 Sep 1952, *Dittmer 6900* (UNM). **McKinley Co.**: S of Ft. Wingate, 1 mi S of Forest Service boundary on road 400, 14 Sep 1976, *Manthey 1417* (UNM). **Valencia Co.**: *Baca 241* (UNM). **Texas. Brewster Co.**: mid slopes Nine-Point Mesa, 65 mi S of Alpine, igneous soil, 4200 ft, infrequent shrub, 3 Jul 1959, *Warnock & Johnston 17441* (SRSC, fide Mike Powell). **Culberson Co.**: Sierra Diablo Mountains, Wild Rose Canyon, Victoria Wildlife Management Area, 13 Jun 1973, *Sikes & Smith 579* (LL); Sierra Diablo Refuge, ca. 2.5 mi NW of headquarters, South Fork of Victoria Canyon, 5000 ft, 20 Oct 1962, *Read A-479* (SRSC digital image!). **Hudspeth Co.**: Sierra Diablo, upper (limestone) slopes of Victoria Canyon, near Vivian McAdoo Ranch, ca. 30 mi N of Allamoore, 10 Jul 1945, *McVaugh 7357 and 7357a* (MO, SMU); N end of Quitman Mts., 8 mi W of Sierra Blanca, steep rocky (igneous) slopes, abundant in canyon, leaflets dimorphic, those on sterile branchlets broad & obtuse, 21 Apr 1947, *McVaugh 8036* (TEX); Sierra Diablo, Victoria Canyon near its upper end, 29 Jun 1943, *Waterfall 4798* (NY). **Jeff Davis Co.**: Davis Mts., deep rocky canyon, along bed of stream, 15 Jun 1926, *Palmer 30928* (MO); Davis Mts., E of Mt. Livermore, in deep rocky canyon, 4 Jun 1928, *Palmer 34344* (MO). **Presidio Co.**: Chinati Mtns. State Natural Area, Upper Cinco de Mayo Canyon, parallel and to W of San Antonio Canyon, bouldery slopes of N-S trending canyon, even-grained, "composted granite" red substrate in the drainage bottom, Gray oak woodland with *Baccharis glutinosa*, *Brickellia laciniata*, *Ungnadia speciosa*, *Viguiera stenoloba*, *Rhus virens*, *Prosopis*, *Celtis*, *Opuntia imbricata*, *Aloysia wrightii*, *Garrya*, and *Fraxinus*, elev. 4322 ft., shrub 1 m tall in dense shade, 16 Sep 2004, *Lott 5302* (TEX). **Mexico**: **Chihuahua**. Barranca del Cobre, south wall, 27° 30'N, 107° 34'W, along river bed and up ravines, in cliffs, and along screes, 3500–4000 ft, 20 ft tall, usually several trunks clustered, 20 Feb

1945, *Hewitt 18* (GH); Santa Eulalia Mts., 6 Apr 1885, *Pringle 137* (NY); Santa Eulalia Mts., 13 Apr 1886, *Pringle 851* (NY). **Coahuila**. Mpio. Ramos Arizpe, Sierra de la Paila, Ejido el Cedral por el cañón El Carmen, 25° 58' N, 101° 32' W, bosque esparcidos de *Quercus glaucoides*, *Q. gravesii*, *Pinus arizonica* y *Juniperus flaccida*, suelo calcareo, 1300–1600 m, 16 Jun 1980, *Castillo Q. & Aguilera 773* (TEX).

A collection from the state of Jalisco, in a natural habitat but apparently far out of range for *Fraxinus cuspidata*, appears to be that species but it needs to be reexamined. **Jalisco**. Barranca of Guadalajara, 10 Jul 1894, *Pringle 5886* (GH).

FRAXINUS GOODDINGII Little, J. Wash. Acad. Sci. 42: 373. 1952. **TYPE**: **USA**. **Arizona**. **Santa Cruz Co.**: Patagonia Mts., Sycamore Canyon, steep rocky slopes, 4000–5000 ft., 15 May 1936, *L.N. Goodding s.n.* (holotype: US, digital image!; isotype: US, digital image!).

Shrubs or small trees, 1.5–4 m; twigs terete; bark smooth, gray, with large scales; winter buds brownish. **Leaves** persistent or mostly so, pinnate, 2.5–6.5 cm, mostly clustered (fascicled) at tips of spur shoots; leaflets subcoriacous, (3–)5–7(–9), glabrous on both surfaces, rarely short-hirsute with curved hairs, glossy adaxially, densely scaly-punctate abaxially, not papillose, blades (0.8–)1–2 cm x (0.4–)0.5–1.4(–1.8) cm, broadly elliptic, elliptic-obovate, or elliptic-ovate to ovate, elliptic-lanceolate, or lanceolate, apex acute to obtuse or rounded, rarely acuminate, base acute to obtuse, rounded, or truncate, margins subentire or usually crenate to crenate-serrate with 1–4 pairs of teeth on the distal half; lateral petiolules 0(–2) mm (leaflets sessile to subsessile), winged; rachis 15–50 mm, narrowly winged; petiole bases on raised pedestals, sometimes with tawny-viscid hairs. **Flowers** bisexual and unisexual (species polygamous), appearing before or with leaves, wind pollinated; pistillate calyx present and persisting at base of samaras; petals absent. **Samaras** 11–16(–20) mm, body cylindric to subcylindric, wings 2, arising from proximal 1/3 to distal 1/3 of body, 3–4 mm wide.

Flowering Feb–Apr. Rocky slopes, cliff bases, arroyos, canyons, limestone, oak and oak-pine woodland, desert scrub; 1100–1700 m; Arizona; Mexico (Sonora, including Isla Tiburón).

Felger et al. (2001, p. 261) described the general aspect of *Fraxinus gooddingii*: "Usually shrubby, often a small, multiple-trunked tree 7-8 m with an upright growth habit and slender twigs. … Often evergeen, or the leaves yellowing and falling in early spring at flowering time, and new leaves appearing with the flowers or later in spring, or sometimes winter deciduous during cold weather."

"*Fraxinus gooddingii* is distinguished from the closely related species *F. greggii* by the following characteristics: (1) twigs, buds, and petioles densely and minutely tomentose with multiradiate fulvous hairs, instead of young twigs slightly gray puberulent; (2) leaflets more numerous, 5–9, commonly 7, instead of 3–7 (or 1); (3) leaflets elliptical, broader and thinner, usually acute at apex, often slightly puberulent beneath, obtuse at apex, glabrous except for the minute peltate hairs; (4) leaflet margin flat or slightly reflexed, crenulate or serrulate above middle, instead of reflexed, entire or crenulate; (5) wing of fruit decurrent nearly to base, instead of slightly decurrent at upper end" (Little 1952, p. 375).

Particularly diagnostic of *Fraxinus gooddingii* (compared to species it might be confused with in sterile form, *F. greggii* and *F. cuspidata*) is the close, flocculent vestiture of tiny, white, multiradiate hairs on young twigs, buds, and petioles. The other species, at the same places, do not produce multiradiate hairs but instead have a sparse (to dense) covering of sessile to short-stipitate, orange, glandular, peltate scales. In *F. gooddingii*, also, the petiole, rachis, and abaxial midvein sometimes are densely hirtellous-villous with white hairs. *Fraxinus gooddingii* is apetalous and its

terete-bodied fruits are more similar to those of *F. greggii* than to *F. cuspidata*. Fruits of *F. gooddingii* and *F. cuspidata* are contrasted in Figure 6.

The molecular study by Wallander (2008) confirmed the hypothesis of close relationship between *Fraxinus gooddingii* and *F. greggii*. Their consistent differences are summarized in the following couplet.

1. Leaves mostly clustered at tips of spur shoots; leaflets 5–7(–9), subcoriacous, ovate to elliptic or elliptic-lanceolate, apex acute to obtuse or sometimes acuminate, margins subentire to crenate-serrate with 1–4 pairs of teeth on the distal half; rachis 15–50 mm long; young twigs, buds, and petioles with close, flocculent vestiture of tiny, white, multiradiate hairs; fruit bodies subterete to terete ..... *Fraxinus gooddingii*

1. Leaves spaced along distal portions of stems; leaflets (1–)3–5, coriaceous, oblanceolate or obovate to rhombic-elliptic or elliptic, apex rounded, margins entire or shallowly crenate with 1–3 pairs of teeth on the distal half; rachis (0–)3–15(–22) mm long; young twigs, buds, and petioles with sparse covering of sessile to short-stipitate, orange, glandular, peltate scales; fruit bodies distinctly flattened ..... *Fraxinus greggii*

Collections examined and mapped: **USA. Arizona. Cochise Co.**: Dragoon Mountains, Slavin Gulch, ca. 18 km (by air) ESE St. David, 31.8802800 - 110.0230600, 1492m, 2 May 2010, *Katcher s.n.* (ARIZ fide SEINET); Whetstone Mountains, French Joe Canyon, 17.5 km (by air) SSW Benson, 31.8101 - 110.3939, rocky canyon bottom, 1575 m, 24 April 2010, *Van Devender s.n.* (ARIZ fide SEINET); ca. 6 mi W of New Mexico border in foothills of the Guadalupe Mountains, 31.3711000 - 09.1574000, locally scattered on NW-facing limestone slope, *Mortonia, Rhus, Acacia, Opuntia, Fouquieria*, Chihuahuan Desert, 1350m, 26 May 1981, *Yatskievych 81-186* (ARIZ fide SEINET). **Santa Cruz Co.**: Tumacacori Mts., Rock Corral Spring, 3800 ft, 9 Jun 1979, *Fletcher 3900* (UNM); Peña Blanca Mts., 3 May 1935, *Goodding 4751* (NY); rocky north-facing ledges and slopes above small canyon, about 1/2 mile north of Rock Corral Cayon, Atascosa Mountains, west of Tumacacori (2.1 miles west of Interstate 19), Semidesert grassland, 3750 ft, 8 Dec 1989, *Johnson 89-185* (GH); Coronado National Forest, Sycamore Canyon, 16 mi WNW of Nogales, oak woodland, 4100 ft, 30 Jun 1956, *Little 17075* (GH); Coronada Natl. Forest, S of Peña Blanca Recreation Area, Ariz. Rte. 289, grassland with *Quercus emoryi, Q. oblongifolia, Arctostaphylos pungens, Rhus choriophylla*, shrub or small tree 1-5 m tall, 8-9 Sep 1976, *McGill & Lehto L20365* (NY). **MEXICO. Sonora**. Along road between Colonia Morelos and Colonia Oaxaca, about 8 mi from Colonia Morelos, 24 Apr 1981, *Bowers s.n.* (ARIZ fide SEINET); Sierra de los Ajos, 17.8 mi by road N of Bacoachic, SE of Cerro La Cieneguita, on steep SE-facing slope above canyon bottom in oak woods with *Eysenhardtia orthocarpa, Garrya wrightii, Rhus choriophylla, Ipomoea longifolia, Muhlenbergia*, and *Dalea versicolor* 25 Jul 1993, *Fishbein 1249* (ARIZ fide SEINET, TEX); Sierra de los Ajos, SE trending tributary of Cañon Hondo, 1 km SE of Cerro La Cieneguita, about 3.7 mi N of Rancho La Volanta, 22 Apr 1995, *Fishbein s.n.* (ARIZ fide SEINET); Mpio. Magdalena de Kino, Magdalena, Rancho la Tinaja Colorada, unos 15 km al NE de Magdalena de Kino, 11 Aug 1996, *Flores M. s.n.* (ARIZ fide SEINET); 6.3 mi E of bridge at Huasabas, rocky slope, small tree ca 3 m high, ca 4200 ft, 23 Feb 1987, *Landrum 5443* (TEX); Sierra Baviso, 17 mi SE of Magdalena, on road to Cucurpe, S of the Palm Canyon, 19 Mar 1978, *McCarten s.n.* (ARIZ fide SEINET); Sierra Baviso, 17 mi SE of Magdalena on road to Cucurpe, Palm Canyon, 19 Mar 1978, *McCarten s.n.* (ARIZ fide SEINET); 9 mi E of Esqueda, along road to Angostura Playa, 8 Sep 1961, *Mason s.n.* (ARIZ fide SEINET); S-facing side canyon ca 1 mi upstream from road entrance to Cajon Bonito, 1 May 1976, *Mason 3189* (ARIZ fide SEINET, NY!); Palm Canyon, 19 mi E of Magdalena along the road to Cucurpe, 25 Jun 1977, *Mason s.n.* (ARIZ fide SEINET); region of the Río de Bavispe, Canon del Temblor, 24 Aug 1940, *Phillips 736* (ARIZ fide SEINET, GH); 5.8 mi E of Río de Bavispe by Huasabas to El Coyote and Huachinera road, on the rim of the Cruce del Diable, 18 Mar 1979,

Reichenbacher s.n. (ARIZ fide SEINET); Sierra La Madera, 2.5 miles by dirt road, northwest of Los Remedios at Arroyo Remedios and 9.3 miles by dirt road east-northeast of Ímuris, 20 Sep 1982, *Reichenbacher 1181* (ARIZ fide SEINET); Sierra La Madera, 2.2 miles by microwave tower road, NW of tower turnoff, 6.5 miles by microwave tower road E of Mex Hwy 15 & 2 at Ímuris, 22 Sep 1982, *Reichenbacher 1243* (ARIZ fide SEINET); Mpio. Agua Prieta, isolated hill NE of Sierra Anibacachi, Rancho La Calera, ca. 10 km (by air) SW of Agua Prieta, Chihuahuan desert scrub on limestone, 1287 m, 10 Apr 2003, *Reina G. 2003-370* (TEX); 11.6 km al NE de Ímuris, sobre Mexico 2, cañada El Corral, 12 Aug 1995, *Reina G. s.n.* (ARIZ fide SEINET); 11 mi W of Cucurpe, 13 Sep 1934, *Shreve s.n.* (ARIZ fide SEINET); Dead Bull Canyon, near Arizpe, 17 Mar 1982, *Thompson s.n.* (ARIZ fide SEINET); 1.6 mi (by road) S of Imuris, 16 Apr 1964, *Turner s.n.* (ARIZ fide SEINET); 2 mi (by road) E of Colonia Oaxaca, 3 Oct 1965, *Turner s.n.* (ARIZ fide SEINET); ca. 34 roadmiles E of turnoff of Sonora, Hwy 12 at Esqueda on road to El Tigre, 30 Jan 1982, *Van Devender s.n.* (ARIZ fide SEINET); Mpio. Santa Ana, Santa Ana, Rancho El Otate, Arroyo Los Otates, 30° 17' 55" N, 110° 52' 32" W, locally common 2-2.5 m shrub, rocky slope, 12 Apr 1998, *Van Devender 98-430* (ARIZ fide SEINET, NY, TEX); Mpio. Fronteras, Rancho Carro Quebrado, 10.3 km SE of Esqueda on road to La Playa and Río Bavispe Valley, 1219 m, 11 Apr 2003, *Van Devender 2003-440* (TEX); Mpio. Nacori de Garcia, Nacori de Garcia, 1134 m, 13 Apr 2003, *Van Devender 2003-528* (TEX); Mpio. Agua Prieta, Cerro El Caloso (= Calichoso) S of Rancho San Marcos, ca 8 km (by air) E of Caballona, 1272 m, 17 Apr 2007, *Van Devender 2007-427* (TEX); Huasabas, Km 223 NE of Huasabas, 10 May 1992, *Walker s.n.* (ARIZ fide SEINET); 5 mi N of Fronteras, Hacienda de San Rafael, region of the Río Bavispe, 3800 ft, shrub 4 m, 9-12 Aug 1941, *White 3880* (ARIZ fide SEINET, GH, NY, TEX); Sierra de la Cabellera, Cañon de la Bellota, region of the Río Bavispe, 4300 ft, shrub 5 m, 7-10 Oct 1941, *White 4674* (ARIZ fide SEINET, GH, NY).

Wilder et al. (2007) have documented the presence of *Fraxinus gooddingii* on Sierra Kunkaak of Isla Tiburón, disjunct far to the west of the main range of the species. Similar to *Canotia holocantha* Torr. (and others) on Isla Tiburón (Wilder et al. 2008), the presence of the ash there is hypothesized to be relictual from a broader Pleistocene distribution. **MEXICO**. **Sonora**. Isla Tiburón, deep canyon beyond Simmen Haax waterhole, 25 Oct 2007, *Felger 07-116* (ARIZ fide SEINET); Isla Tiburón, deep canyon beyond Simmen Haax waterhole, 25 Oct 2007, *Felger 07-121* (ARIZ fide SEINET); Isla Tiburón, deep canyon in the northern interior of the Sierra Kunkaak, 26 Oct 2007 *Wilder 07504* (ARIZ fide SEINET).

Records of many other collections of *F. gooddingii* from Santa Cruz Co., Arizona, can be found on SEINET (2010).

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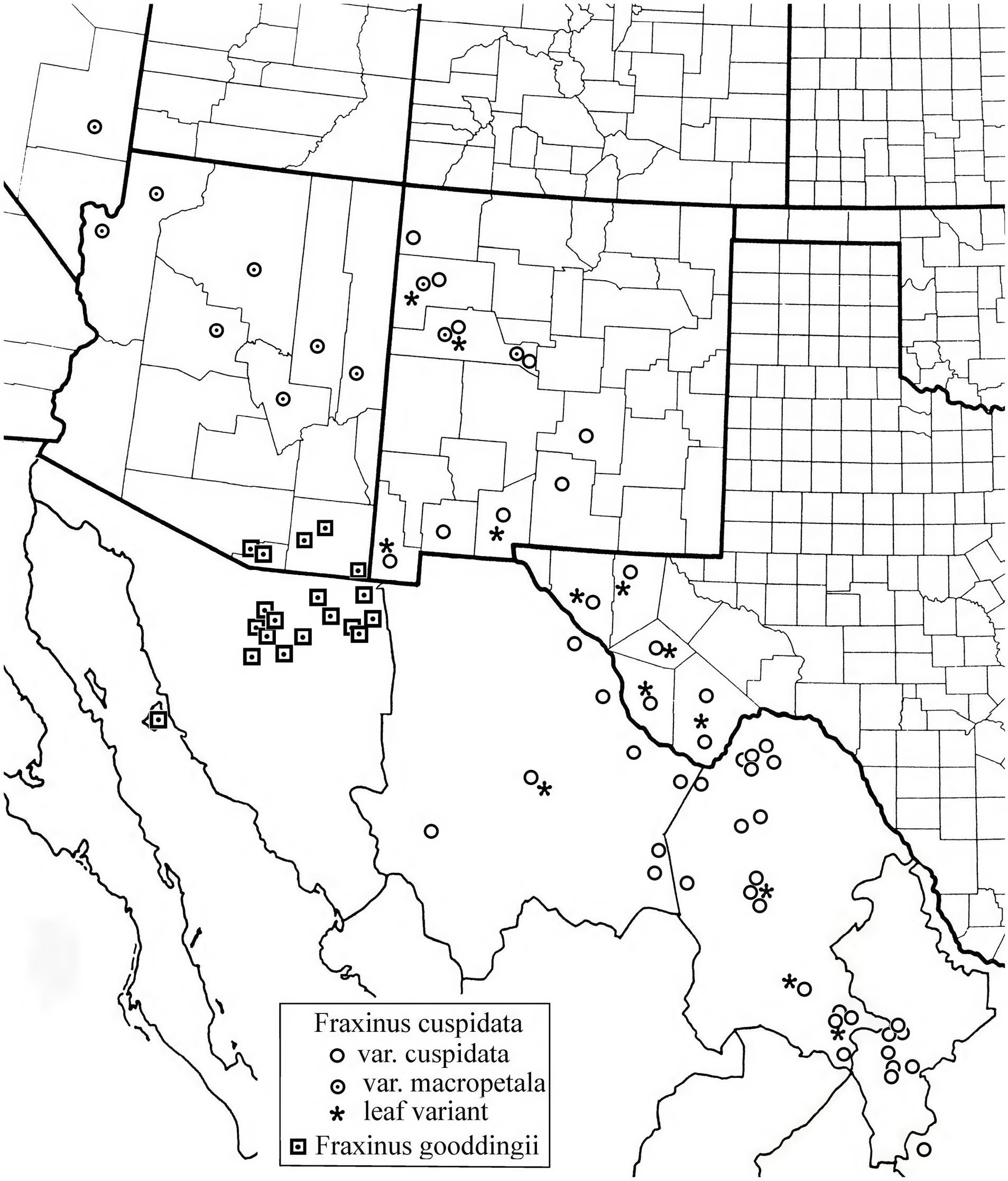

Figure 1. Geographic ranges of *Fraxinus cuspidata* (var. *cuspidata* and var. *macropetala*) and *F. gooddingii*. Intermediates are common in counties where symbols are placed for both varieties of *F. cuspidata*. Collection localities of atypical variants of *F. cuspidata* (see text) are indicated. Records are mostly from TEX-LL, UNM, and ARIZ. Some have been added from SEINET, especially for *F. gooddingii* in Mexico (see text).

Figure 2. Collection of *Fraxinus cuspidata* var. *cuspidata* showing dimorphism (*Pringle 137*, NY).

Figure 3. Collections of atypical (small-leaved) *Fraxinus cuspidata* var. *cuspidata* in fruit (*Read A-479*, SRSC).

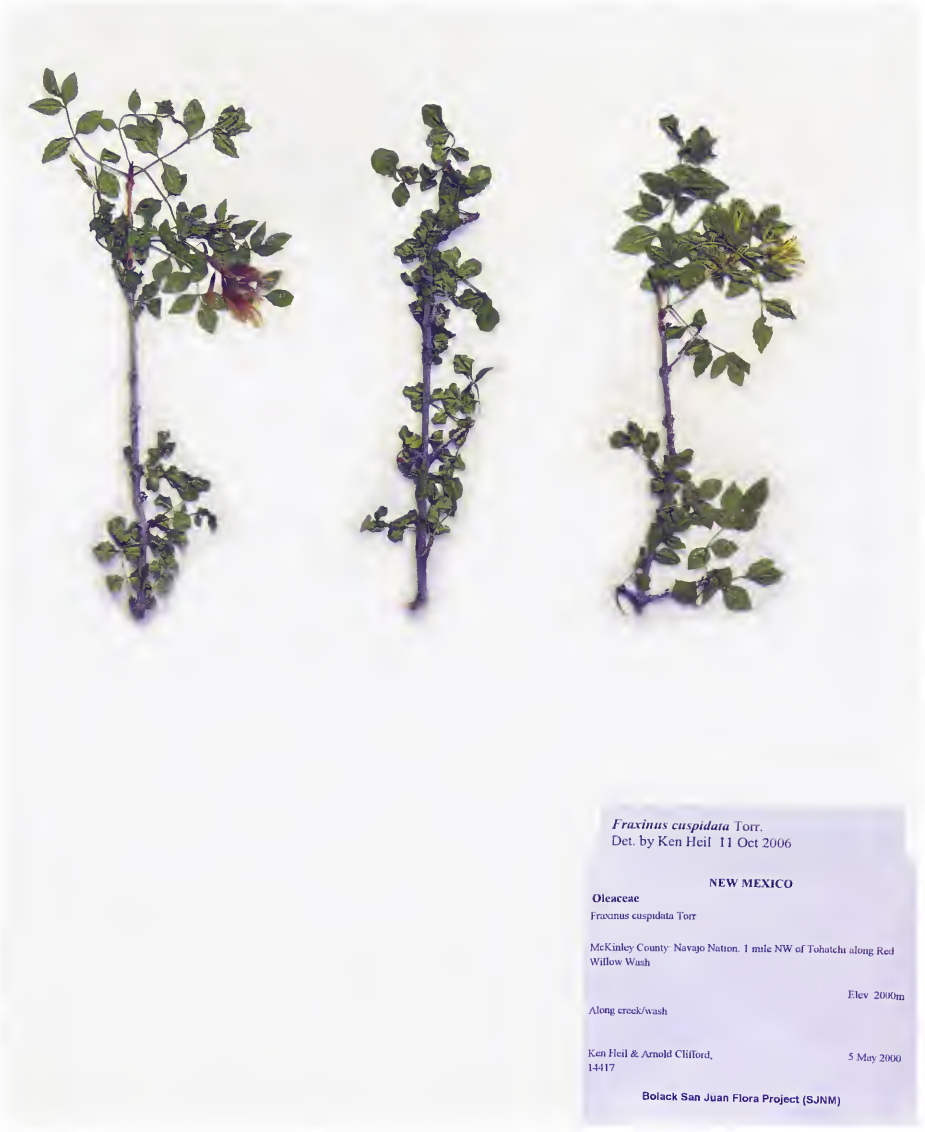

Figure 4. Collection of near (?) typical *Fraxinus cuspidata* var. *macropetala* in flower (*Heil & Clifford 14417,* SJNM).

Figure 5. Collection of typical *Fraxinus cuspidata* var. *macropetala* (*Atwood 25883*, SJNM).

Figure 6. Collection of typical *Fraxinus gooddingii* (*Van Devender 2007-427*, TEX).

Fig. 7 Samaras of *Fraxinus cuspidata* (A) and *F. gooddingii* (B) (From SEINET 2010)

Nesom, G.L. 2010. Taxonomy of the water ashes: *Fraxinus caroliniana, F. cubensis,* and *F. pauciflora* (Oleaceae). Phytoneuron 2010-39: 1–13. Mailed 1 September 2010.

TAXONOMY OF THE WATER ASHES: *FRAXINUS CAROLINIANA*, *F. CUBENSIS*, AND *F. PAUCIFLORA* (OLEACEAE)

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ABSTRACT

Water ash has commonly been identified as a single species, *Fraxinus caroliniana* Miller, but is here recognized to comprise three distinct entities each treated at specific rank: (1) *F. caroliniana* sensu stricto, from northern Florida west along the Gulf Coast to Texas and Oklahoma and north along the Atlatic coast to Virginia; (2) *F. cubensis* Griseb., from Cuba and the southern two-thirds of the Florida peninsula; and (3) *F. pauciflora* Nutt., from northern Florida and southern Georgia. All three are similar in gross morphology and occur in swampy or riverine habitats but the ranges of *F. caroliniana* and *F. cubensis* are essentially parapatric, while the range of *F. pauciflora* lies mostly within that of *F. caroliniana* and overlaps with *F. cubensis*. Samaras of *F. caroliniana* sensu stricto are broad, often rhombic-elliptic, (11–)13–19-nerved per side, and 3-winged at a low frequency, while those of *F. cubensis* are narrower, 5–9-nerved per side, and consistently 2-winged. Samaras of *F. pauciflora* are similar in shape to those of *F. cubensis*, but the abaxial leaf surfaces are covered by a cuticular micro-reticulum similar to that characteristic of the *F. americana* complex. County-level distributions are mapped and a key, descriptions, and typifications are provided. A lectotype is designated for *Fraxinus hybrida* Lingelsheim.

KEY WORDS: *Fraxinus caroliniana*, *Fraxinus cubensis*, *Fraxinus pauciflora*, Florida

The name *Fraxinus caroliniana* Miller is currently commonly used in southeastern USA herbaria and floristic accounts to identify various expressions of water ash — all with samara bodies flat and winged nearly to the base. This broad view has been adopted by Miller (1955), Long and Lakela (1976), Duncan and Duncan (1988), Godfrey (1988), Wallander (2008), and Weakley (2010) and by Wunderlin and Hansen (2003, 2010) even to include another swamp species, *F. profunda* (Bush) Bush, in synonymy. Brown and Kirkman (1990) and Nelson (1995) separated *F. profunda* but identified all water ash as *F. caroliniana* without citing synonyms. Long and Lakela (1976, p 687) were particularly emphatic: "This species [*F. caroliniana*] is extremely variable, but variations scarcely deserve taxonomic recognition." Other students of the woody flora of northern and central Florida, however, have maintained *F. profunda* as a separate species and recognized a distinction between *F. caroliniana* and *F. pauciflora* Nutt. (e.g., Sargent 1894, 1902; Small 1913; Kurz & Godfrey 1962; Clewell 1985; Nesom 2010), using characters similar to those in the present study. *Fraxinus cubensis* Griseb. of southern Florida apparently has never been recognized in the USA, but it has been treated as *F. caroliniana* var. *cubensis* (Griseb.) Lingelsh. in the Cuban flora (Leon & Alain 1957).

In working out a taxonomic treatment of *Fraxinus* for the developing FNANM volumes, it became evident that "water ash" includes three entities. In addition to the trees with characteristically broadly elliptic to rhombic and often 3-winged samaras (= *F. caroliniana* sensu stricto), others produce narrower, consistently 2-winged and differently veined samaras. Then, after becoming familiar with the distinctive abaxial leaf surface of *F. americana* L. (white ash), I saw that some trees with the more narrowly 2-winged samaras have an abaxial foliar morphology similar to *F. americana* and stand apart from the other water ashes. Field observations confirm the distinctiveness of these (identified as *F. pauciflora*, termed here as "swamp white ash"). In overview, each of the three

expressions of water ash is recognized here at specific rank: *F. caroliniana*, *F. pauciflora*, and *F. cubensis*.

Trees of these three taxa are generally similar in vegetative features and all grow in swampy or riverine habitats, often or characteristically with their bases submerged. The key below separates them on the basis of features of the samaras and abaxial foliar epidermis. *Fraxinus profunda* is added to the key since it has sometimes been confused with water ash in Florida. All are contrasted with *F. americana*, a species of upland woods with a different samara morphology.

1. Samara bodies plump-subterete, wings 3–7 mm across at widest point, lateral veins 3–5 on each side of the wing, all originating from near the top of the body, essentially parallel with the wing margins; upland habitats ..... **Fraxinus americana**
1. Samara bodies flattened, wings 8–22 mm across at widest point, lateral veins 5–9 or 11–19 on each side of the wing, originating in sequence from along the major vein paralleling the body edge, angling upward; swamp and riverine habitats.

2. Large trees; leaflets (7–)9–15(–25) cm x (2.5–)3.5–7(–11) cm, bases often rounded, less commonly obtuse to acute or acuminate; samaras (35–)40–70(–75) mm, wings gradually expanded from near the base of the body to proximal 1/2, (5.5–)6–10(–12) mm wide ..... **Fraxinus profunda**
2. Shrubs to small trees; leaflets mostly (4–)5–11(–12) cm x (1.5–)2–5(–6) cm, bases obtuse to acute or abruptly attenuate; samaras (25–)30–50 mm, wings expanded gradually from near base, (10–)12–20(–22) mm or 6–10(–12) mm wide.

3. Leaflet abaxial surfaces micro-foveolate-papillose (use 20–40X lens) with a cuticular reticulum overlaying and obscuring the epidermal surface, minute glandular peltate scales not evident ..... **Fraxinus pauciflora**
3. Leaflet abaxial surface without a cuticular overlay, the epidermal surface visible, minute glandular peltate scales usually evident and abundant.

4. Samaras 35–46 x (10–)12–20(–22) mm, rhombic to broadly elliptic, elliptic-obovate, oblong-obovate, or rhombic-ovate, wings 2–3, lateral veins (11–)13–19 on each side of the wing; fruit body usually half or more than half the length of the samara ..... **Fraxinus caroliniana**
4. Samaras (25–)30–50(–54) x 6–10(–12) mm, obovate-oblanceolate to narrowly obovate or narrowly elliptic-obovate, wings 2, lateral veins 5–9 on each side of the wing; fruit body half or less than half the length of the samara ..... **Fraxinus cubensis**

FRAXINUS CAROLINIANA Miller, Gard. Dict., ed. 8. 1768. *Calycomelia carolmiana* (Miller) Kostel., Allg. Med.-Pharm. Fl. 3: 1004. 1834. *Leptalix caroliniana* (Miller) Raf., Alsographia Amer. 36. 1838. *Fraxinus americana* var. *caroliniana* (Miller) D.J. Browne, Trees America 398. 1857. *Fraxinus nigra* subsp. *caroliniana* (Miller) Wesmael, Bull. Soc. Roy. Bot. Belgique 31: 113. 1892. **TYPE: USA.** "Raised from seeds which were sent from Carolina in the year 1724, by Mr. Catesby" (K).

Fraxinus platicarpa Michx., Fl. Bor.-Amer. 2: 256. 1803. *Calycomelia platicarpa* (Michx.) Kostel., Ind. Hort. Bot. Prag. 26. 1844. *Fraxinus caroliniana* var. *platicarpa* (Michx.) Lingelsh., Bot. Jahrb. Syst. 40: 221. 1908. **TYPE: USA.** "HAB. in Carolina" (P presumably).

Fraxinus pallida Bosc, Mém. Cl. Sci. Math. Inst. Natl. France 1808: 201. 1809. *Leptalix pallida* (Bosc) Raf., Alsogr. Amer. 33. 1838. *Calycomelia pallida* (Bosc) Kostel., Ind. Hort. Bot. Prag. 26. 1844. As synonym of *F. caroliniana* fide Sargent (1894).

Fraxinus caroliniana Miller var. *latifolia* Roemer & Schultes, Syst. Veg. 1: 279. 1817. **TYPE: USA.** Protologue: "A Pensylvania ad Carolinam, rarius." As synonym of *F. caroliniana* based on geography.

Fraxinus triptera Nutt., Gen. N. Amer. Pl. 2: 232. 1818. *Samarpses triptera* (Nutt.) Raf., New Fl. 3: 93. 1838 ("1836"). *Fraxinus platicarpa* Michx. var. *triptera* (Nutt.) A.W. Wood, Class-Book Bot., ed. 1861. 598. 1861. *Fraxinus americana* var. *triptera* (Nutt.) D.J. Browne, Trees America 399. 1857. **TYPE: USA. South Carolina.** (Holotype: PH?). Protologue: "8. *triptera*. Leaflets (about 7?) obovate, entire, subsessile, beneath tomentose, oblique at the base; samara very broad, elliptic-obovate, most 3-winged! attenuated at the base. HAB. In the oak-forests of South Carolina. Fruit at first sight almost similar to Halesia, more rarely 2 than 3 winged, the seed also 3-sided. Points of the leaves obtuse, the under side paler and softly villous, the common petiole and nerves beneath smooth." Treated by Nuttall as a different species than his "5. caroliniana" and "6. platycarpa."

Nuttall later added comments (1849, p. 63): "I observed fruit of this curious species many years ago, in winter, in the oak forests of South Carolina, and as I thought, the leaves of the same; but I am now in doubt whether the leaves than collected actually belonged to the same plant with the fruit. I must therefore leave the species in the same imperfect manner I than found it, as I have never since seen any other specimen. [paragraph] The fruit is the most curious of any in the genus, at first sight almost similar to that of an Halesia, being nearly of the same breadth; the samara, in fact, appeared to be more rarely 2 than 3 winged, the seed itself was also 3-sided, at the base the fruit is attenuated into a very slender peduncles without being at all terete. Perhaps it is merely a variety of *F. platycarpa*."

Fraxinus curvidens Hoffsgg., Verz. Pfl.-Kult., Nachtr. 2: 29, 118. 1826. As a synonym of *F. caroliniana* fide Sargent (1894).

Fraxinus cordata Raf., Alsographia Amer. 34. 1838. **TYPE: Florida.** "139. Fr. L. [Leptalix] *cordata* Raf. foliolis petiol. ovatis ellipt. integris, basi subcordatis, apice attenuatis obtusis. supra reticul. glabris lucidis, subtus glaucis pubescens—very distinct sp. from Florida, disc. by Kin, large folioles 4 to 6 inches long 2 or 3 broad." As synonym of *F. caroliniana* fide Wunderlin and Hansen (2010), but Rafinesque's description of the leaflet bases as "subcordate," emphasized by the epithet, does not correspond to known native ashes of Florida.

Fraxinus platicarpa Michx. var. *oblanceolata* M.A. Curtis, Amer. J. Sci. Arts 57: 408. 1849. *Fraxinus caroliniana* var. *oblanceolata* (M.A. Curtis) Fernald & Schub., Rhodora 50: 188. 1948. **TYPE: USA. South Carolina.** Berkeley Co.: Santee Canal, Santee swamp, [no date], *H.W. Ravenel s.n.* (holotype: CHARL?; isotypes: GH, NY!).

Fraxinus platicarpa Michx. var. *pubescens* M.A. Curtis, Amer. J. Sci. Arts 57: 408. 1849. *Fraxinus caroliniana* var. *pubescens* (M.A. Curtis) Fernald, Rhodora 39: 442. 1937. *Fraxinus caroliniana* forma *pubescens* (M. A. Curtis) Fernald & Schubert, Rhodora 50: 188. 1948. **TYPE: USA. South Carolina.** Berkeley Co.: Santee Canal, Santee swamp, [no date], *H.W. Ravenel s.n.* (holotype: CHARL?; isotypes: GH, NY!).

Fraxinus nuttallii Buckley, Proc. Acad. Nat. Sci. Philadelphia 12: 444. 1860. **TYPE: USA. Alabama.** Wilcox Co.: In swamps, no date, *Buckley s.n.* (PH?). For this small swamp tree with 3-winged fruits, Buckley noted that "As Nuttall had not material for a complete description, none can tell what is meant by his *Fraxinus triptera*; but as possibly he may have intended the tree now described, I call it Nuttall's Ash." As synonym of *F. caroliniana* based on morphological description and geography.

Fraxinus rehderiana Lingelsh. in Engler, Pflanzenr. 4(Heft 72): 42. 1920. *Fraxinus caroliniana* var. *rehderiana* (Lingelsh.) Sargent, J. Arnold Arbor. 2: 173. 1921. **TYPE: USA. Virginia.** Isle of Wight Co.: Banks of Blackwater River near Zuni, 19 Aug 1908, *A. Rehder s.n.* (holotype: B?; isotype: GH). Lingelsheim made this observation: "Species fortasse hybrida, e *F. pennsylvanica* et *F. caroliniana* orta, forma parallela *F. hybridae*." Placed here as a synonym

of *F. caroliniana* based on its morphological description and geography and on Sargent's assessment.

Fraxinus caroliniana Miller forma *hypomalaca* Fernald & Schubert, Rhodora 50: 189. 1948. **TYPE**: **USA. Virginia**. Greensville Co.: Fontaine Creek, SW of Haley's Bridge, cypress swamp, wooded bottomland, 9 Jul 1946, *M.L. Fernald & H.E. Moore 15139* (holotype: GH!; isotype: GH!, PH).

Fraxinus caroliniana Miller forma *lasiophylla* Fernald & Schubert, Rhodora 50: 189. 1948. **TYPE**: **USA. Virginia**. Southampton Co.: Darden's Pond N of Courtland, upper border of sandy and peaty shore, 15 Sep 1946, *M.L. Fernald, B.H. Long*, and *I.D. Clement 15335* (holotype: GH!; isotype: GH!, PH).

Trees or shrub-like trees with several leaning trunks and often with buttressed bases, 2.5–10(–15) m; twigs terete; bark light gray, with thin appressed scales, not deeply furrowed; winter buds brown. **Leaves** deciduous, pinnate, 12–40 cm, leaflets 5–7(–9), glabrous on both surfaces or sparsely pubescent abaxially along the veins, rarely over the surface, dark green adaxially, paler or whitish abaxially, not scaly-punctate, not papillose, blades 4–12(–15) cm x (1–)2–3(–6) cm, lanceolate to ovate-lanceolate, elliptic, or elliptic-oblong, lateral vein pairs (5–)7–9(–12), apex obtuse to acute or acuminate, base obtuse to truncate or rounded, margins shallowly serrate to crenulate on distal 4/5–2/3, lateral petiolules 2–3(–15) mm, not winged; rachis (2–)3–9(–12) cm; petiole bases not raised; leaf scars shallowly hemispheric to depressed obovate, apex very slightly convex or notched. **Flowers** unisexual (species dioecious), appearing before leaves, wind-pollinated; pistillate calyx present, persisting or not; petals absent. **Samaras** 35–46 mm, rhombic to broadly elliptic, elliptic-obovate, oblong-obovate, or rhombic-ovate, body flattened and abruptly acuminate to stipitate at the base, usually half or more than half the length of the samara, wings 2(–3), arising from the base or proximal 1/4 of body, (10–)12–20(–22) mm wide; lateral veins (11–)13–19 on each side of the wing.

Flowering Feb–Apr(–May). River and stream banks, alluvial woods, flatwoods, cypress-gum swamps (often in water), overcup oak-water locust-water elm, swamp and pond margins, depressions, ditches and canals, roadside swales; 3–60(–100) m; Ala., Ark., Fla., Ga., La., Miss., N.C., S.C., Tex., Va. Water ash, pop ash.

FRAXINUS CUBENSIS Griseb., Cat. Pl. Cub. 170. 1866. *Fraxinus caroliniana* var. *cubensis* (Griseb.) Lingelsh., Bot. Jahrb. Syst. 40: 221. 1908. *Fraxinus caroliniana* subsp. *cubensis* (Griseb.) Borh., Bot. Közlem 58: 176. 1971. *Fraxinus pennsylvanica* subsp. *cubensis* (Griseb.) E. Murray, Kalmia 13: 6. 1983. *Fraxinus pennsylvanica* var. *cubensis* (Griseb.) E. Murray, Kalmia 13: 6. 1983. **TYPE**: Cuba. Protologue: "Cuba occ., in depressis pr. Zarabanda," 1865, *C. Wright 45* (holotype: GOET; isotype: K digital image!)." Collections at GH and NY (2 sheets) are possible type material — Cuba, without other collection data, *C. Wright 3624* — if, as in Wright collections from the southwestern USA, field numbers and published collection numbers are inconsistent. The GOET and K labels, however, specify "*Wright 45*." Another possible type specimen (S digital image!) has a Charles Wright label but is unnumbered.

Small trees or shrubs 3–14 m, sometimes multi-trunked from the base; twigs terete; bark grayish to gray-brown, morphology; winter buds reddish brown to brown. **Leaves** deciduous, pinnate, 12–23 cm, spaced along branches; leaflets (3–)5(–7), subcoriaceous, glabrous on both surfaces except hirsute-pilose along abaxial midvein and lateral vein axils, rarely puberulent-hirsute on abaxial lamina, green to yellowish green, scaly-punctate abaxially, not papillose, blades (4–)4.5–10.5(–13) cm x (1.5–)2–5(–5.5) cm, narrowly to broadly elliptic to elliptic-obovate or obovate, apex acute to acute-acuminate, lateral vein pairs 7–11, base acute to obtuse, margins shallowly serrate to denticulate on distal 1/2–2/3, lateral petiolules 4–10 mm, not winged; rachis 4.5–10 cm, not winged; petiole bases not raised; leaf scars transversely elliptic and shallow concave, 3–5 mm wide. **Flowers**

unisexual (species dioecious), appearing before the leaves, wind pollinated; pistillate calyx present and persisting at base of samaras; petals absent. **Samaras** (25–)30–50(–54) mm, obovate-oblanceolate to narrowly obovate or narrowly elliptic-obovate, body flattened, half or less than half the length of the samara, wings 2 (very rarely 3), arising from middle/proximal 3/4 of body, 6–10(–12) mm wide, lateral veins 5–9 on each side of the wing.

Flowering Feb–Mar. Hardwood hammocks, swamp forests and low woods, apparently most commonly along river and creek banks and pond and lake edges; 0–5 m; Fla.; West Indies (Cuba). Cuban water ash

I have seen collections of *Fraxinus cubensis* from the following Florida counties: Brevard, Citrus, Collier, Glades, Highlands, Hillsborough, Lee, Manatee, Marion, Martin, Monroe, Okeechobee, Orange, Palm Beach, Polk, Sarasota, and Sumter. Various localities on the shores of Lake Okeechobee are in Glades, Martin, Okeechobee, and Palm Beach counties.

Specimens examined from **CUBA**: Prov. Santa Clara, Peninsula de Zapata, on the edge of Ciénaga de Zapata, in swampy forests, small tree, 1 Feb 1924, *Ekman 18368* (NY); Prov. Matanzas, Mpio. Martí, Ciénaga del Majaguillar al NO de Martí, Ciénaga de Gonzalito cerca del Canal de Blanquizal, 5 m, bosque secundario de ciénaga, 20 Feb 2009, *Greuter 27019* (NY); Cayo la Lisa, Ciénaga de Zapata, Las Villas 24 Feb 1941, *León et al. 19562* (NY); Los Sabados, Hacienda El Jiqui, Peninsula de Zapata, 16 Jul 1920, *Roig & Gemata 2145* (NY); Prov. Matanzas: Ciénaga de Zapata, along road between Australia and Playa Larga, close to Calal de La Laguna, evergreen or semi-evergreen forest on limestone, temporarily inundated, 13 Apr 1995, *Rova et al. 2261* (GOET digital image!, DNA voucher). All are localities in western Cuba, just east of Havana.

Fraxinus cubensis is similar to *F. caroliniana* in most features except fruit morphology (I have not seen *F. cubensis* in nature, however, to provide a comparison of its growth habit). Samaras of *Fraxinus caroliniana* appear to be far more variable than those of *F. cubensis* (Figs. 4 and 5), and although narrower samaras of *F. caroliniana* may approach of those of *F. cubensis* in outline, the distinction in venation is consistent (as in the key above). It might seem justifiable to treat the two as conspecific, but the remarkably sharp divide in geographical distribution would appear to mark some kind of biological isolation and I have not observed unequivocal intermediates in samara morphology. It will be interesting to investigate the area of apparent parapatry toward evaluation of their apparent reproductive isolation, as hypothesized here.

Samaras of *Fraxinus caroliniana* are 3-winged (3-carpellate) at a low frequency (ca. 5–20% on an individual) over the whole range of the species and it is more common than not to find 3-winged fruits on any single specimen. Samaras of *F. cubensis* are consistently 2-winged, but I have encountered 2 collections with 3-winged fruits: Manatee Co., Palmetto, 21-23 Aug 1895, *Nash 2431* (GH); Sumter Co., Sumter Citrus Wildlife Management Area, W of Bushnell, Withlacoochee River bottoms, 13 Aug 1958, *Kral 7847* (GH).

FRAXINUS PAUCIFLORA Nutt., N. Amer. Sylva 3: 61, plate 100. 1849. **TYPE: USA. Georgia.** [Charlton Co.:] "collected in Georgia in the neighborhood of 'Trader's Hill,' by the late indefatigable and excellent botanist, Dr. Baldwyn," no date (holotype: PH; possible isotype: PH).

Fraxinus platicarpa Michx. var. *floridana* Wenzig, Bot. Jahrb. Syst. 4: 185, plate II, 11. 1883. *Fraxinus floridana* (Wenzig) Sargent, N. Amer. Silva 14: 39. 1902. **TYPE: USA. Florida:** "Cabanis! in hb. Berol." (holotype: B?, fragment GH). "Samara calycis dentibus parvis triangularibus saepe destructis, lanceolata, alae margo in longitudinem lateris partis inferioris latior quam in *Fr. quadrangulata* Mchx., angustior quam in *Fr. platycarpa*, apice obtusissima emarginata basi acuminato-attenuata. 0,054 m. longa, ala 0,040 m. lata, pars inferior 0,027 m

long, plana, longitudinaliter sulcata." A GH collection from 1830 by E.F. Leitner is noted to be a possible type, but the protologue indicates that the type was collected by Jean Louis Cabanis (1816–1906) — see bibliographic notes by Sargent (1902, p. 39).

Fraxinus hybrida Lingelsh., Bot. Jahrb. Syst. 40: 220. 1908. **LECTOTYPE** (designated here): **USA.** Florida. Duval Co.: swamps, near Jacksonville, Aug [1890?], *Curtiss 2321* (NY!; isolectotypes: GH-2 sheets!). Lingelsheim cited as syntypes "Curtiss 2321!, Nash 941!, 1698!" — *Nash 941* (E digital image!) and *Nash 1698* (E digital image!, GH!). Curtiss made a series of collections of this species in July and August 1894, numbered as 4536, 4536A, 4536B, and 4536C (see citations below). Label data of the three lectotype specimens do not specifiy the year of collection, but a Curtiss collection of *F. caroliniana* sensu stricto also numbered "2321" was made in 1880 (Georgia, Decatur Co., Oct 1880, *Curtiss 2321*, GH!).

Fraxinus profunda var. *ashei* E.J. Palmer, J. Arnold Arbor. 13: 417. 1932. **TYPE: USA.** Florida. [Suwannee Co.:] near Hildreath, growing in the water, 15 May 1929, *W.W. Ashe s.n.* (probable holotype: NCU, digital image!). Palmer (1932) did not specifically cite NCU as the herbarium of deposition of the type but he noted that "My attention was first called to this tree by Mr. W.W. Ashe, for whom the variety is named, and on whose notes and collections I have drawn to supplement my own made this season in the region where it grows." There is no specimen at GH of Ashe's collection from near Hildreath and it seems evident that Palmer had a loan of his material from NCU. The NCU sheet is annotated by hand as "type."

Trees 4–10(–15) m tall, usually single-stemmed and erect from the base; twigs terete; winter buds dark brown. **Leaves** deciduous, pinnately compound, 15–30 cm, leaflets (3–)5(–7), terminal leaflet rarely absent, petioles 3.5–9 cm, bases not raised on pedestals, petiole plus rachis 6–15 cm, petiolules 5–11 mm, blades oblong-elliptic, elliptic, elliptic-lanceolate, or ovate-lanceolate, terminal (5.5–)7–13(–16) cm x (2–)3.5–7 cm, lateral usually slightly smaller, dark green and glossy adaxially, olive abaxially, apices acute to abruptly or gradually acuminate, bases rounded to obtuse or attenuate, lateral veins 7–11 pairs, margins shallowly dentate-serrulate to serrulate on the distal 2/3; petiole base shallowly notched adaxially, leaf scars apically shallowly convex to subtruncate, 3–4(–6) mm wide. **Flowers** unisexual (species dioecious), appearing before the leaves, wind-pollinated; pistillate calyx ca. 1 mm, persisting at base of samara; petals absent. **Samaras** 32–47 mm, elliptic-oblanceolate to narrowly obovate, bodies (16–)20–26 mm, flattened, usually channeled along the middle, half or less than half the length of the samara, wings 2, gradually expanded from near the base to middle of the body, (7–)9–10(–12) mm across at widest point, lateral veins 8–12 on each side.

Flowering Mar–Apr. Sloughs, swamps, usually in standing water; 2–20 m; Florida, Georgia. Swamp white ash, pop white ash, water white ash.

Additional collections examined. **Florida**. Alachua Co.: S of Gainesville, Paynes Prairie State Preserve, hammock NE of Alachua Sink, northern portion of hammock, 10 April 1982, *Easterday 858* (FLAS); along Newnans Lake, Gainesville, 13 July 1936, *West & Evers s.n.* (FLAS). Baker Co.: along Cedar Creek, 5.5 miles N of Glen Saint Mary, 8 Jun 1950, *Kurz s.n.* (FSU). Bay Co.: bank of Econfina River, E side, 0.8 mile W of Youngstown, 24 Apr 1951, *Kurz s.n.* (FSU). Clay Co.: Hibernia, Mar 1869, *Canby s.n.* (NY-3 sheets). Dixie Co.: California Creek, 7.5 mi SSW of Cross City, hammock, partially underwater, limestone undersurface, 8 m tree in water, 13 May 1966, *McDaniel 7489* (FSU). Duval Co.: swamps, near Jacksonville — 27 Aug 1894, *Curtiss 4536* (NY), 27 Aug 1894, *Curtiss 4536A* (NY), 2 Jul 1894, *Curtiss 4536B* (NY), 1894, *Curtiss 4536C* (NY); 7.5 mi E of Baldwin or 4 mi W of Marietta on U.S. Rte 90, swamp, 7 Jul 1949 *Kurz s.n.* (FSU); 1-2 mi W of Atlantic Beach, 6 Sep 1949, *Kurz s.n.* (FSU); 7.8 mi E of Jacksonville city limits on US Rte. A1A, swamp, 7 Jun 1950, *Kurz s.n.* (GH, VDB); 2.4 miles E of Jacksonville city limits on S side of road at A1A Rte bridge, swamp, 8 Jun 1950, *Kurz s.n.* (FSU). Flagler Co.: cypress swamp near Andalusia, 18 April 1940, *West & Arnold s.n.* (FLAS). Jefferson Co.: Jefferson Co.: Wet hammock, 0.5 mi W of Aucilla River, by US Rt. 98, E of Newport, 14 June 1983, *Godfrey 80693* (FLAS); slough between

Newport and Aucilla River, growing in 2 feet of standing water, 2 May 1956, *Kral & Godfrey 2379* (FLAS, FSU, LL, NY); at junction of the Wascissa River and Aucilla River, in swampy area, small tree (15 feet), [no date], *Williams s.n.* (FSU). Lafayette Co.: Lafayette Co.: Mallory Swamp Conservation Area, SW of Branford, highly degraded mosaic of bottomland forest and basin swamp, 4 Sept 2004, *Abbott 19177* with Heaney (FLAS); on E side of Fla. Rte 51, 9 mi N of U.S. Rte 19, N of Mayo. in water, 5 Sep 1949, *Kurz s.n.* (FSU, GH). Lake Co.: along W side of the St. Johns River along Fla. Rte 40, 22 Jul 1950, *Kurz s.n.* (FSU, NY); Tavares, low hammock, 13 June 1940, *Murrill s.b.* (FLAS); vicinity of Eustis, in water, Lake Norris, small tree 12-15 ft high, 16-25 Aug 1894, *Nash 1698* (AA, NY); vicinity of Eustis, cypress swamp at Eldorado, tree 30-50 ft high, 16-25 Aug 1894, *Nash 1698* (NY). Levy Co.: Waccasassa Bay State Preserve, well west of Jack's Creek; coastal hydric hammock, with scattered freshwater depressions and scattered areas of mixed hardwoods, 9 June 1997, *Abbott 10489* with Judd (FLAS); swamp ca. 6 mi N of Cedar Key, 22 Jul 1960, *Godfrey 60102* (SMU). Liberty Co.: floodplain woods along the Ochlockonee River, Rte 20, W of Tallahassee, 2 Jun 1950, *Kurz s.n.* (NY, VDB); N of Fla. Rte 20, in W floodplain of Ocklockonee River, 2 Jun 1950, *Kurz s.n.* (FSU); Liberty Co.: Telogia Creek, access road to boat ramp off Co. Rd. 67A, 1.8 air mi ENE of Telogia, common small trees along sloughs and in swamp, ca. 10–25 feet tall, trunks slender, erect, and single, none in fruit, *Fraxinus caroliniana* common (not collected) and in fruit along sides of creek, 12 Jul 2010, *Nesom 2010-F3* (FLAS, GH, NY); W side of Hwy 65 0.6 mi S of jct with Hwy 267 S of Hosford, ca. 50 yards N of bridge over Telogia Creek, edge of swamp, tree 40 feet tall, fruits out of reach and not collected, 12 Jul 2010, *Nesom 2010-F4* (FSU, GH, NY, TEX); W side of Hwy 65 0.6 mi S of jct with Hwy 267 S of Hosford, ca. 50 yards N of bridge over Telogia Creek, edge of swamp, small, singe-trunked trees in immediate vicinity of *Fraxinus profunda* (*Nesom F4*), not in fruit, 12 Jul 2010, *Nesom 2010-F5* (FLAS, GH, NY, TEX). Marion Co.: swamp along Rainbow River, Dunellon, in water, small tree with several trunks from near the base, bases of trunks enlarged, 1 May 1976, *Godfrey 74890* (FSU, VDB); riverine forest beneath the Oklawaha River bridge ("Eureka Mountain") along C-316, just E of Eureka, 24 Jul 1985, *Hansen & Wunderlin 10456* (TEX); Ocala National Forest, along Mormon Branch, a tributary of Juniper Run, moist forest along creek, 30 July 1994, *Judd 8036* (FLAS); W edge of Oklawaha R. swamp, dominant species, with *N. sylvatica* var. *biflora* also abundant, 25 June 1975, *Martin & Cooper 735* (FLAS); 1/4 mi E of Olawaha River, Eureka, riverbottom swamp, frequent, from upper branches of uprooted tree 45 ft. high, 6 in. diameter, 17 May 1963, *Ward & Laessle 3484* (FSU). Nassau Co.: White Oak Plantation in the wedge formed by the jct of the Little St. Mary's River and St. Mary's River, ca. 8-10 mi NW of Yulee, swamp forest 100-200 yards NW of the Pavilion Bldg along the St. Mary's River, tree 6 m tall in standing water, 23 Jul 1997, *Wilbur 68108* (BRIT, FLAS). Orange Co.: 5 mi SE of Fort Christmas, in a swamp, 19 Sept 1929, *O'Neill s.n.* (FLAS). Osceola Co.: deep swamps, near Kissimmee, tall slender tree, 2 Apr 1931, *Palmer 38356* (AA, NY). Seminole Co.: Seminole/Lake County, along banks of Wekiva River, dominant, 30 Jun 1990, *Bacchus 5492* (FLAS, FSU); 2 mi NW of Sanford on U.S. Rte 17, 22 July 1950, *Kurz s.n.* (FSU). Putnam Co.: along Oklawaha River, Cedar Landing, 7 July 1935, *Arnold s.n.* (FLAS). St. Johns Co.: bank of St. Johns River, 27 March 1910, *Hood 72069* (FLAS); riverside, Tocoi, 7 June 1940, *West & Arnold s.n.* (FLAS). Suwannee Co.: 5 mi NW of Fort White off of US 27 in Ichetucknee Springs State Park, ca. 0.2 mi W of Old South entrance, 0.8 mi S of US 27 bridge, floodplain forest and swamp, 6 May 1992, *Herring 709* (FLAS). Wakulla Co.: swamp by East River, by first bridge after entering St. Marks National Wildlife Refuge on Lighthouse Rd, single-stemmed tree ca. 9 m tall, 17 Jul 1981, *Godfrey 79020* (FLAS, FSU, VDB); river swamps, Aucilla River, 5 mi above mouth, 10 Apr 1934, Griscom 21597 (AA); St. Marks, low woods, 29 Apr 1914, *Harbison 1499* (AA); N side of Wakulla River, along U.S. Rte 319, 27 Sep 1949, *Kurz s.n.* (FSU); E side of Wakulla River, swamp, 14 Jun 1950, *Kurz s.n.* (FSU); St. Marks NWR, Lighthouse Road (Hwy 59), area of double bridge over East River Pool, ca. 1.8 road mi S of the Refuge Headquarters and Visitor Center, common small trees in standing water, few in fruit, trunks erect, single, 13 Jul 2010, *Nesom 2010-F6* (FLAS, GH, NY); St. Marks NWR, Lighthouse Road (Hwy 59), area of double bridge over East River Pool, ca. 1.8 road mi S of the Refuge Headquarters and Visitor

Center, single tree at edge of swamp, above water level, trunk single, erect, ca. 40 feet tall, profusely fruiting, 13 Jul 2010, *2010-Nesom F7* (FSU, GH); W side of Wakulla River, swamp along N side of Hwy 319/95, ca. 3 air mi NW of town of St. Marks, common trees, trunks single, erect, 10-40 feet tall, few in fruit and fruits high and out of reach, 13 Jul 2010, *Nesom 2010-F8* (FLAS, FSU, GH, NCU, NY, TEX); near Rd 59 ca 6 mi N of the St. Marks Lighthouse, cypress-hardwood swamp, abundant, tree up to 20 feet tall, 20 Jun 1950 *Redfearn 2510* (FSU, GH). Walton Co.: Choctawhatchee River delta, 12 April 1975, *Suttkus 75-6-12* (FLAS). Washington Co.: E edge of Caryville, 20 Aug 1950, *Kurz T-3* (FSU). **Georgia**. Charlton Co.: along St. Mary's River, Trader's Hill section, 15 Apr 1940, *Kelley 50* (AA); St. Mary's River swamp, below Trader's Hill, 12-15 Jun 1895, *Small s.n.* (AA, NY); St. Mary's River swamp, below Trader's Hill, 24-26 Jul 1895, *Small s.n.* (AA, NY). Decatur Co.: at easternmost bridge at head of Florida Sterile Hospital Pond, near Jink's Siding, NE of Chattachoochee, in creek swamp, 19 Aug 1975, *Gholson 4562* (FLAS). Dougherty Co.: along the Flint River at Albany, 24-28 May 1895, *Small s.n.* (AA, NY). Citations of collections from FLAS are provided by Walter Judd, who identified the specimens.

In the Trader's Hill area of southeastern Georgia, whence the type of *Fraxinus pauciflora*, collections also have been made of *F. caroliniana*. J.K. Small collected both species there in June of 1895. USA. **Georgia**. Charlton Co.: St. Mary's bottomland, Thompson's Landing, 21 Jul 1958, *Cypert 113* (GA); branch of St. Mary's River, Trader's Hill, small tree, 3 Apr 1918, *Harbison 4* (AA); St. Mary's River, Cedar Landing, river swamp, 31 May 1930, *Harper 231* (GH); in the St. Mary's River swamp, below Trader's Hill, 12-15 Jun 1985, *Small s.n.* (AA).

The abaxial leaf surface of *Fraxinus pauciflora* has a distinctive morphology otherwise known only in the *F. americana* group (*F. americana*, *F. biltmoreana*, *F. smallii*, and *F. albicans*). This is easily observed with a dissecting microscope (40X) and once the nature of the character is understood, a 10–20X hand lens may be sufficient to make the observation.

Lingelsheim (1908) was fully aware of the distinctive abaxial leaf morphology of *Fraxinus americana* and upon studying specimens of *F. pauciflora* from Florida recognized the similarity in this feature of these water ash trees to white ash. His explicit speculation that they were hybrid in origin between *F. americana* and *F. caroliniana* was reflected in his choice of epithet.

Collections at NY of *Fraxinus pauciflora* studied by Gertrude Miller were annotated by her (on 25 May 1951) as "*Fraxinus americana* complex" or in a few cases as "*Fraxinus americana* L. — *caroliniana* Mill." Earlier, at GH in 1950, she had annotated some collections of *F. pauciflora* as "*F. floridana* Sarg.?" She was aware of the epidermal distinction and in her monograph (Miller 1955, p. 25) she observed that these trees, which she knew at the time only from Lake County, Florida, "seem to be the result of a rare or chance hybrid between a member of the red ash complex and one of the white ash complex. … This hybrid has persisted at or near the point where the original hybrid appeared, but has not been able to extend its range, or only very slightly. Until more evidence becomes available, and largely for convenience, in this study the hybrid is arbitrarily called *F. caroliniana* Mill. – *americana* L.?"

Sargent (1902, p. 39, plate 717) also separated *Fraxinus caroliniana* and *F. pauciflora* (using the name *F. floridana* for the latter), observing that "A small Ash-tree which grows in ponds and deep river-swamps in eastern and western Florida and in southern Georgia and which has usually been considered a form of the Water Ash, *Fraxinus Caroliniana*, varies constantly from that species in the form of the fruit. It is desirable that a plate of this second species of Water Ash should appear in a Silva of North America, and although the foliage and winter-buds do not afford characters by which the two trees can be readily distinguished in the herbarium, it is convenient to treat them as species rather than as varieties." Sargent's note that collections of *F. floridana* were made "near Jacksonville,

Eustis, and Apalachicola, Florida, and in Charlton County, southern Georgia" leave little doubt that it is the same species identified here as *F. pauciflora*.

In limited field study in northern Florida (two days in Franklin, Liberty, Leon, and Wakulla counties), I saw *Fraxinus caroliniana* only along the immediate sides of creeks and rivers. *Fraxinus pauciflora* apparently is much more common in that area, occurring within and along the edges of swamps. Only a small percentage (ca. 10–20%) of the *F. pauciflora* trees were in fruit. In other areas, however, label data indicate that *F. caroliniana* sensu stricto has a broader ecological range.

ACKNOWLEDGEMENTS

I am grateful to Terry Peacock, Refuge Manager, St. Marks National Wildlife Refuge, for permission to make collections on the federal property, to staffs at BRIT-SMU, FSU, GH, NY, to Eva Wallander for comments and digital images of *Fraxinus cubensis*, Daniel Ward for discussions and perspective on Florida *Fraxinus* and his comments on the manuscript, and Walter Judd for identifying FLAS collections of water ashes and providing the specimen data for *F. pauciflora* (as cited here), to TEX-LL for hospitality during visits, and to GA and GH for loans to TEX for my study there. This study was done in part under contract for the Flora of North America Association, in conjunction with preparation of the FNANM treatment of *Fraxinus*.

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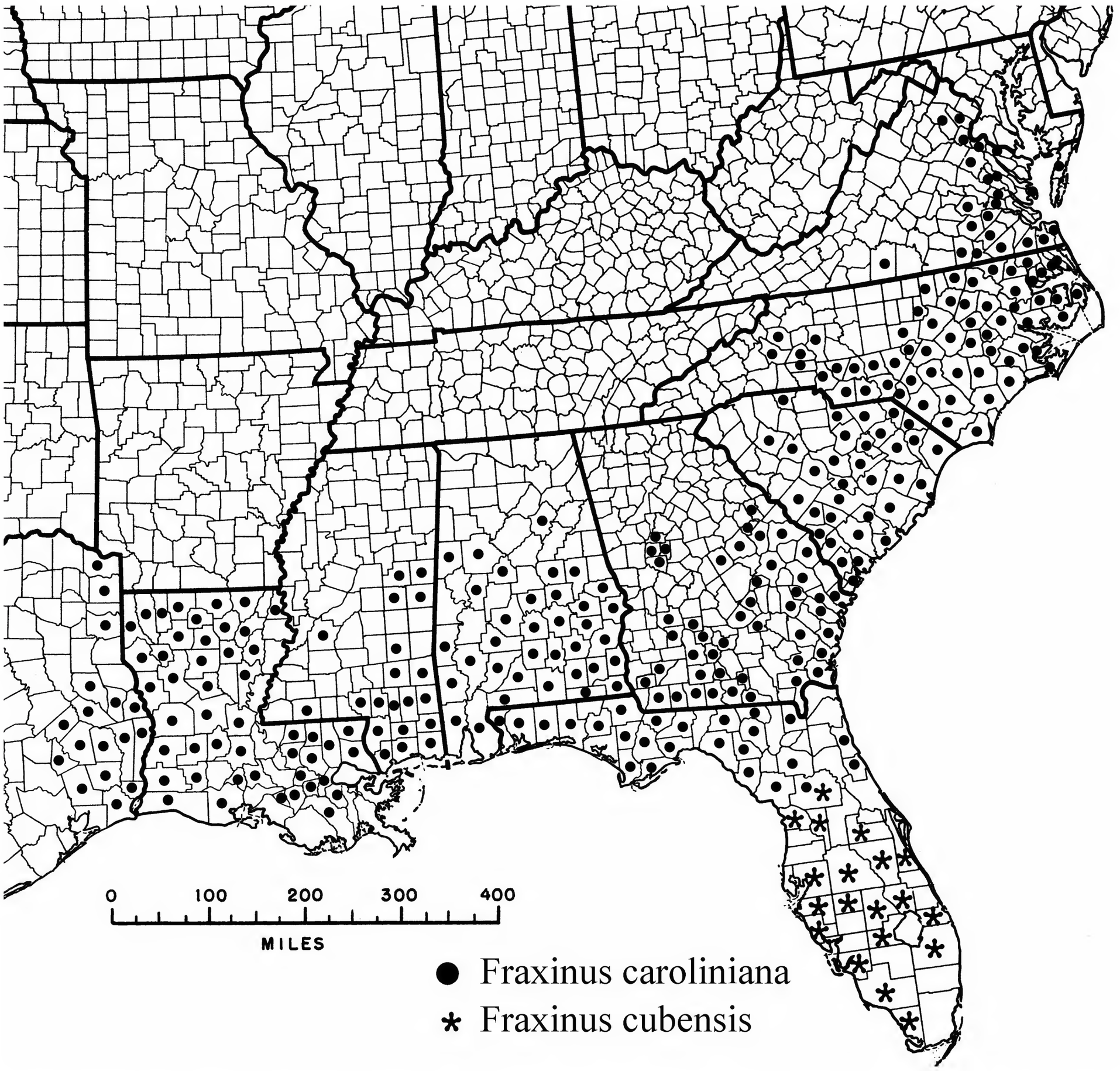

Figure 1. Distribution of *Fraxinus caroliniana* and *F. cubensis*. *Fraxinus cubensis* also occurs in western portions of Cuba (see text).

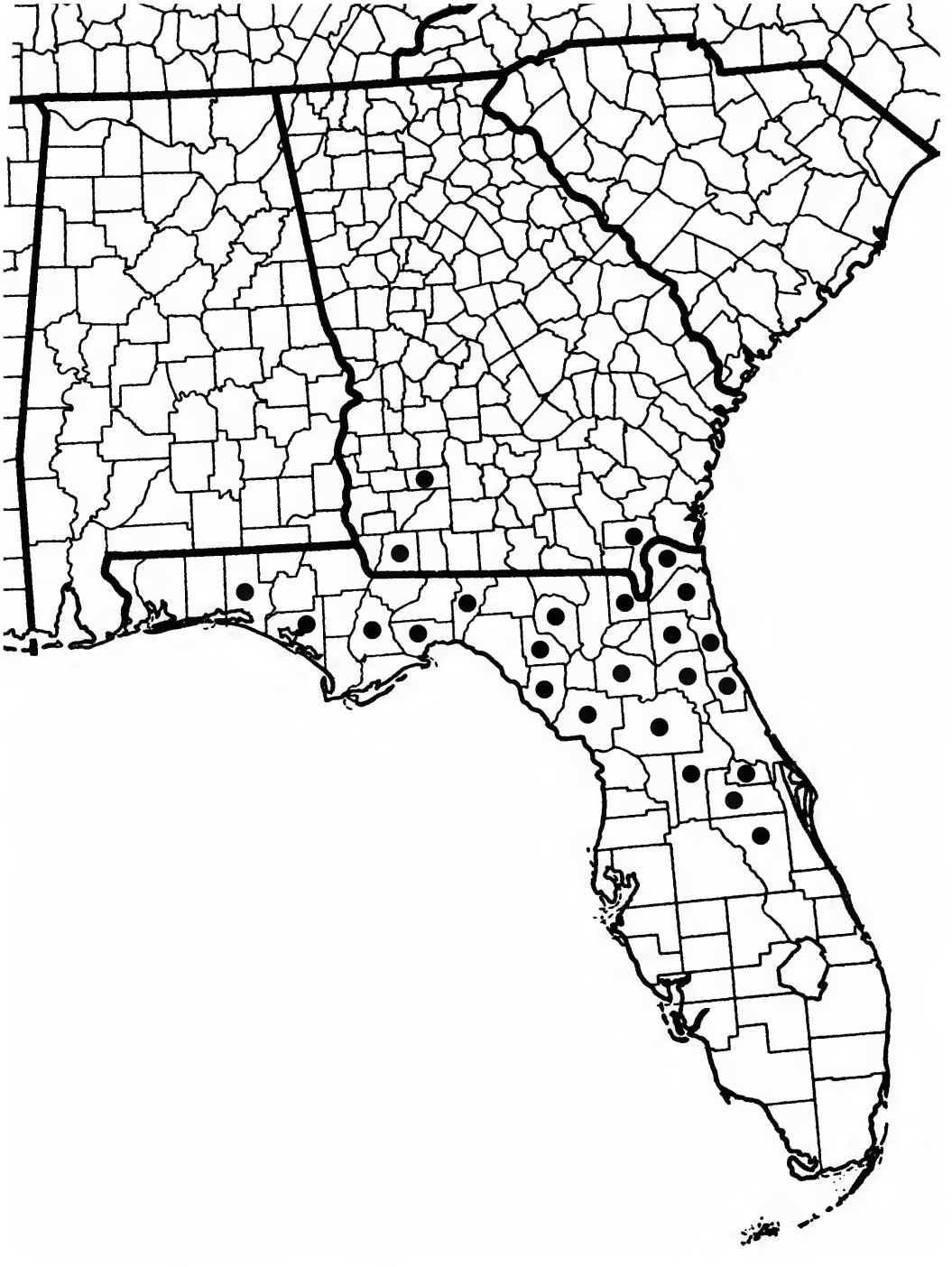

Figure 2. Distribution of *Fraxinus pauciflora*.

Figure 3. Representative samaras of *Fraxinus pauciflora*.

Figure 4. Representative samaras of *Fraxinus cubensis*.

Figure 5. Representative samaras of *Fraxinus caroliniana*.

Turner, B.L. 2010. *Xanthisma pseudorestiforme* (Asteraceae: Astereae), a new gypsophile from Nuevo Leon, Mexico. Phytoneuron 2010-40: 1–6. Mailed 1 September 2010.

XANTHISMA PSEUDORESTIFORME (ASTERACEAE: ASTEREAE), A NEW GYPSOPHILE FROM NUEVO LEÓN, MEXICO

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ABSTRACT

A new gypsophilic taxon, **Xanthisma pseudorestiforme** B.L. Turner, **sp. nov.**, is described from Nuevo León, Mexico. It is closely related to the well-known gypsophile *X. restiforme* from the area of Cuatro Ciénegas in central Coahuila, hence the name. A photograph of the type is provided, along with photos of the habitat, plants in vivo, and a map showing the distribution of each species.
KEY WORDS: Asteraceae, *Xanthisma*, gypsum, Mexico, Nuevo León, Coahuila

Some 30 years ago I described a most remarkable species, *Machaeranthera restiformis* B.L. Turner — now identified as *Xanthisma restiforme* (B.L. Turner) Hartman & Morgan — from gypsum soils near Cuatro Ciénegas, Mexico (Turner 1973), one of the highlights of my many years of fieldwork in Mexico. The novelty was named for its rope-like stems, nothing else in the genus having such an appearance, until the following:

Xanthisma pseudorestiforme B.L. Turner, sp. nov. Figs. 1–5. **TYPE: MEXICO. Nuevo León.** Mpio. Mina, N of Molina, gypsum hillside, 854 m, 26.02219° N, 100.422211° W, shrub 20 cm, widely scattered plants, 4 Sep 2005, *Hinton et al. 28398* (holotype: TEX).

Xanthismi restiformi (B.L. Turner) Hartman & Morgan similis sed differt caulibus ac foliis dense hispidulis (vs. gossypinis), capitulis minoribus (4–5 mm in altitudine vs. 6–8 mm), et bracteis involucralibus setas albas apicales carentibus.

Suffruticose or subshrubs, intricately branched and densely hispidulous, 30 cm tall or less from a tough, woody taproot, presumably forming deep rhizomes. **Leaves** simple, short, ovate blades 2–4 mm long, 2–3 mm wide, sessile, densely hipidulous, ciliate with white waxy trichomes that terminate ill-defined serrations and the apex. **Heads** solitary, discoid, sessile or nearly so. **Involucres** campanulate, the bracts 2–5 mm long in 3–5 series, distinct white apical setaceous apiculae absent. **Receptacles** ca 5 mm across, alveolate, adorned with small scales and short hairs. **Florets** yellow, 30–60 per head; corollas ca 4 mm long, 5-lobed, the lobes acute, ca 1 mm long. **Style branches** flat with densely pubescent, acute appendages. **Achenes** prismatic, ca 1.8 mm long, densely white-pubescent; pappus of numerous stiff bristles ca 4 mm long.

Additional collections examined: **MEXICO. Nuevo León.** Mpio. Mina: NE of Carricitos, gypsum hillside, 935 m, 26.0136° N, 100.46592° W, 23 Jul 2007, *Hinton et al. 28633* (TEX); off Monterrey-Monclova Hwy 53, 6 mi N of Rancho Las Estacas on one of several roads leading N from headquarters — this road passes two watering holes and ends 7 mi N of headquarters, near second water hole on gypsum, 650 m, 26° 25' N, 100° 50' W, 18 Oct 1993, *Patterson 7436* (TEX).

The new species resembles *Xanthisma restiforme* (B.L. Turner) Hartman & Morgan but differs in its densely hispidulous stems and leaves (vs cottony-pubescent), smaller heads (4–5 mm high vs 6–8 mm), and involucral bracts without apical white bristles. The novelty indeed resembles *X. restiforme* so much in habit so that I have coined its name after the fact. No doubt the two taxa are

derived from some ancient gypseous rhizomatous population, this giving rise to the two remarkable populations known today — one in Coahuila, the other in Nuevo León (Fig.1). The locality for *X. pseudorestiforme* also is the home of two other recently described gypsophilous endemics, *Erigeron heleniae* Nesom (Nesom 2007) and *Cryptantha geohintonii* B.L. Turner (Turner 2008).

Xanthisma pseudorestiforme first came to my attention in 1993 by a collection of Thomas F. Patterson (cited above). I annotated it as a possible new species at the time, hoping that additional specimens might be obtained by others, and such has been provided by my good friend George Hinton, who obtained two more collections, including the type and a color photograph of the same. In his covering letter (email), George commented:

> On Sunday I went to a gypsum outcrop near Monterrey, and as I got out of the truck saw a real nice Asteraceae, a dominant species I thought that if no one had been collecting on that gypsum (most likely) it would surely be undescribed Then yesterday night I went to the PRC website [Plant Resources Center, TEX] and found that you had collected it on gypsum near Cuatro Ciénegas — over 100 miles to the NW of the Nuevo León site and 30 years earlier!

George's intuition was correct, of course, but his web site examination could not have picked up the differences that distinguish between the species concerned, nor did he know that I had squirreled away the single sheet of the potential novelty at my disposal, as noted above.

ACKNOWLEDGEMENTS

I am grateful to Guy Nesom for the Latin diagnosis and comments on the paper and to Tom Wendt for the photograph of the holotype. Many thanks to George Hinton for his interesting letter, some of this quoted above, and the excellent collections and photos.

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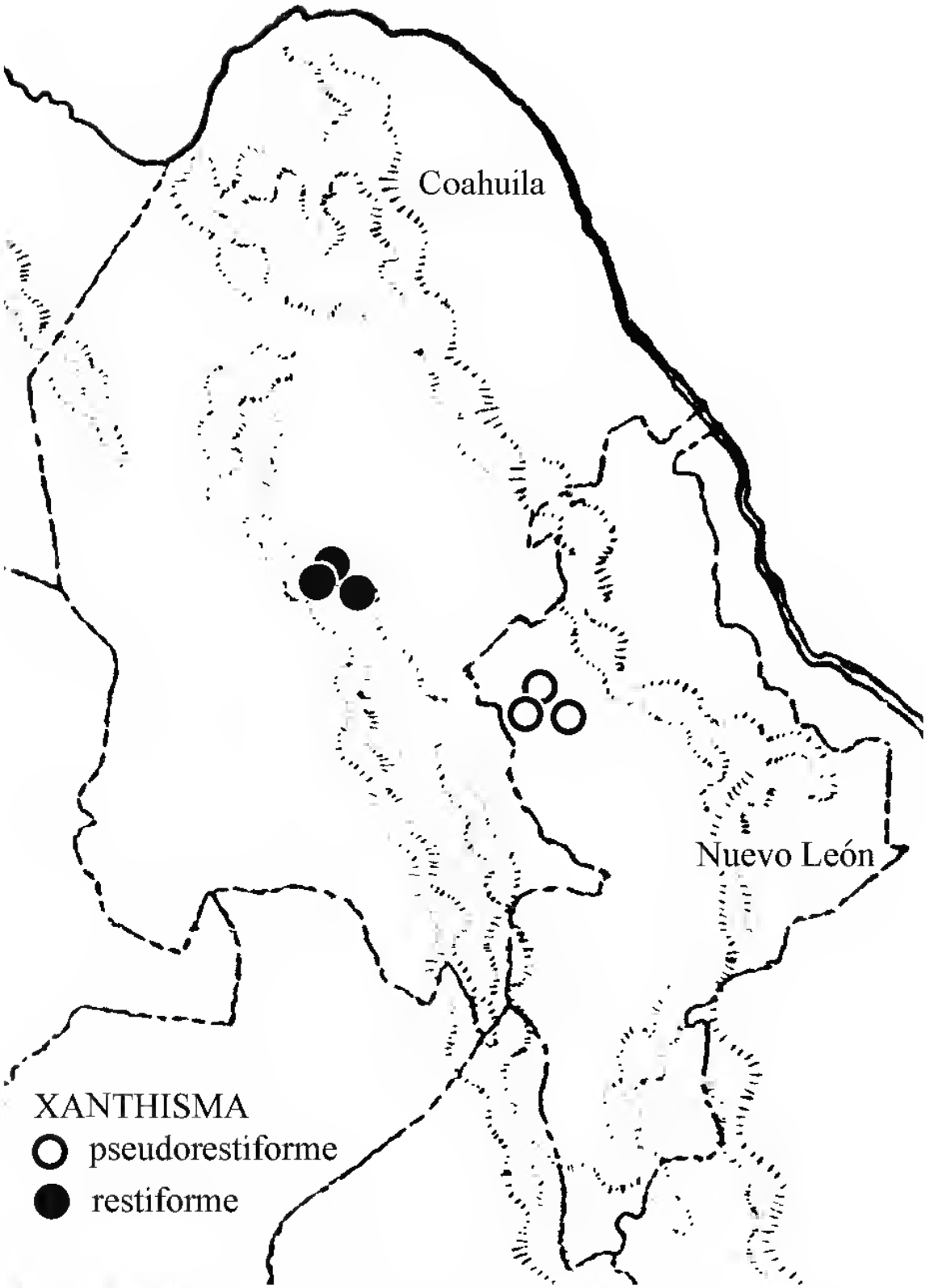

Figure 1 Distribution of *Xanthisma restiforme* and *X. pseudorestiforme*

Figure 2. *Xanthisma pseudorestiforme* (holotype, TEX).

Figure 3. *Xanthisma pseudorestiforme*. Two adjacent shrubs at type locality.

Figure 4. *Xanthisma pseudorestiforme*. Branches and head.

Figure 5. *Xanthisma pseudorestiforme*. Scattered shrubs at type locality.

ABIES FIRMA (PINACEAE) NATURALIZED IN NORTH AMERICA

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ABSTRACT

In North Carolina, *Abies firma*, an introduced fir from Japan, is reported as escaping and establishing for the first time in North America. Momi Fir is an infrequently introduced taxon that has been proposed as a highly suitable ornamental tree, particularly in the southeastern United States. This recent discovery of its ability to naturally produce viable progeny suggests that widespread horticultural use of this coniferous species needs further evaluation. A description and photographs are provided to aid in identification of this taxon.

KEY WORDS: Pinaceae, *Abies firma*, Momi Fir, Alleghany County, North Carolina

An unfamiliar conifer was encountered in Alleghany County, North Carolina during the spring of 2010, while conducting an ongoing survey of the vascular flora of the county. Several saplings were noticed in the vicinity of a secluded residence. The estimated age of these individuals varied from small first year seedlings (ca. 5 individuals) immediately bordering the house to 5-8 year old saplings (1-2 m tall; 2 individuals) and larger 15-20 year old (4-5 m tall; 4 individuals) pole-sized trees growing in neighboring woodland margins along a roadside embankment and a powerline corridor (Fig. 1). The initial assessment of this taxon was confounding. All saplings exhibited branchlets with a planar orientation, and long acicular leaves with spinose-bifid apices (Fig. 2). It became readily apparent that these individuals were expressing a dimorphism from the parent tree. Examination of the property revealed only one possible source, a large 22 m (70+ ft) tall species of *Abies* that had shorter leaves with obtuse-emarginate apices (Figs. 3-4).

Identification and taxonomy.

Most *Abies* species, particularly those introduced, are difficult to identify. A combination of sterile branchlets from both older reproductive trees and younger saplings are needed, but ultimately, examination of mature seed cones is critical for the most accurate identification. However, obtaining ovulate cones from *Abies* spp. can be problematic. Seed cones are produced at the ends of the uppermost branches of the tree. The Alleghany County parent tree was free-climbed to about 18 m, and a fully extended, 5.5 m pole pruner was used to obtain branchlet specimens with cones.

Identification was facilitated primarily by the keys in the Flora of China (Liguo et al. 1999), and cross-referenced with several other sources (e.g., Bailey 1924; Rehder 1940; Bailey and Bailey 1976; Warren and Johnson 1988; Eckenwalder 2009). This taxon was determined to be *Abies firma* Siebold & Zucc. (Japanese Fir, Momi Fir) based on the following diagnostic characteristics:

Young leaves elongate with sharp, bifid apices and a 2-ranked/distichous, planar orientation. Older leaves of reproductive branchlets shorter with obtuse-emarginate apices, and a radially spreading or ascending habit. At least some leaves of cone-bearing brachlets with 2 median and up to 2 additional marginal resin canals. Stomatal bands present as abaxial white bands. Buds scarcely resinous. Seed cones yellowish-green, cylindric, 12-15 cm long. Rachis of the seed cone conical and slender. Seed scales thickest at or below the middle, with oblanceolate exserted bracts that have an abrupt apical cusp. Bracts not reflexed. Seeds with a cuneate-oblong wing. Significant features of habit and morphology are illustrated in Figs. 2-7.

Synonymy and voucher information.

Synonymy follows Liguo et al. (1999) and MBG (2010). Common names for the species are Japanese Fir and Momi Fir.

Abies firma Siebold & Zucc., Beih. Bot. Centralbl. 37. II. 113. 1919.
Abies bifida Siebold & Zucc., Fl. Jap. 2(2): 18, pl. 109. 1842. *Abies firma* Siebold & Zucc. var. *bifida* (Siebold & Zucc.) Mast., J. Linn. Soc., Bot. 18(113): 514. 1881.

North Carolina. Alleghany Co.: Cherry Lane Township, Roaring Gap. Located along Lyons Rd. (SR 1102) in the corner of the Oklahoma Rd. (SR 1100) jct. at 36°23'15.57"N, 80°59'51.68"W, elev.745 m. Parent tree planted in the front yard of an old residence with saplings growing in disturbed areas in the neighboring vicinity. Infrequent (11+ individuals). 1 Apr 2010, *D.B. Poindexter 10-13* (BOON, NCU); 7 Apr 2010, *D.B. Poindexter 10-27* (BOON); 9 Jul 2010, *D.B. Poindexter 10-408* with *A.T. Poindexter* (BOON, NCU).

Discussion.

Momi Fir, an endemic of Japan, occurs in warm temperate forests (Vaario et al. 1999). In its indigenous range, the wood has been utilized for various purposes varying from roof shingles, boards, ship building, and matches to musical instruments (Edwards 2008). In the United States, this introduced tree is rare in the nursery trade. Although it has been used in the Christmas tree industry in western states, it is primarily limited to ornamental specimen trees in eastern arboreta (Gilman & Watson 1993).

Abies firma has not been previously documented as naturally reproducing or naturalizing in North America. Nor has it been reported to occur outside of cultivation anywhere else in the world (GCW 2010). To date, the only nonnative species of *Abies* that has been reported for North America is *Abies alba* Mill., European Fir (Kartesz 2010; USDA, NRCS 2010; Weakley 2010). Coincidentally, the documentation of this taxon also is from North Carolina and its occurrence has been traced back to plantings made in the late 1800s (Weakley 2010).

The presence of more than two resin canals in the leaves of *Abies firma* is a strong diagnostic character that can be used to separate it from *A. alba*, among several other relevant taxonomic morphological characters. Likewise, apparently no native species in North America north of Mexico exhibit more than two resin canals in their leaves (Hunt 1993).

The localized naturalization of *Abies firma* in Alleghany County is a consequence of an initial planting that originated well over 75 years ago (J. Hanks, former landowner, pers. comm.). Once established, *A. firma* can grow ca. 30 cm (12 inches) per year (Gilman & Watson 1993). Most firs reach reproductive maturity on average at 20 years of age; however, growth rates are rather slow, especially in the seedling stage (Gilman & Watson 1993; Edwards 2008). This time required for establishment and the subsequent annual growth rate were used as the basis for age estimations of the individuals at this site. Despite the limited area of occurrence, several of the trees appear to be over 10 years old, thus conforming to the criterion of "naturalized" that was formulated by Pyšek et al. (2004).

According to Gilman and Watson (1993), *Abies firma* "is probably one of the best (if not the best) firs to grow in the southeast." The authors likely reached this conclusion based on the high tolerance of heat and drought exhibited by this species suitable for USDA hardiness zones 5B-8, as well as its preference for acidic soils. In contrast, seedlings at this site apparently generated from self-fertilization, which suggests that the population may be genetically unstable and would likely deteriorate over time. Monoecious firs are generally self-compatible, but this form of reproduction has been shown to reduce seed yield in the North American native Noble Fir (*Abies procera* Rehder)

(Edwards 2008). Likewise, offspring derived from self-fertilization often show signs of inbreeding depression, e.g., reduced growth rates (Edwards 2008).

As a result of the recent discovery of Momi Fir in Alleghany County, it seems that unabated commercialized use of this taxon in the southeast could have long-term consequences upon the landscape (i.e., it could become a more prominent ornamental exotic taxon). Ultimately, widespread horticultural use of this taxon needs further evaluation to assess potential broader-scale ecological impacts.

ACKNOWLEDGEMENTS

I am grateful to the Roaring Gap Donors for graciously providing funding for a long-term study of the vascular flora of Alleghany County, North Carolina. This grant has engendered a wealth botanical discovery, and this paper is a reflection of their financial contributions. I would also like to thank Drs. Guy Nesom, Ralph Thompson (BEREA), and Alan Weakley (NCU) for suggestions and critical reviews of this manuscript.

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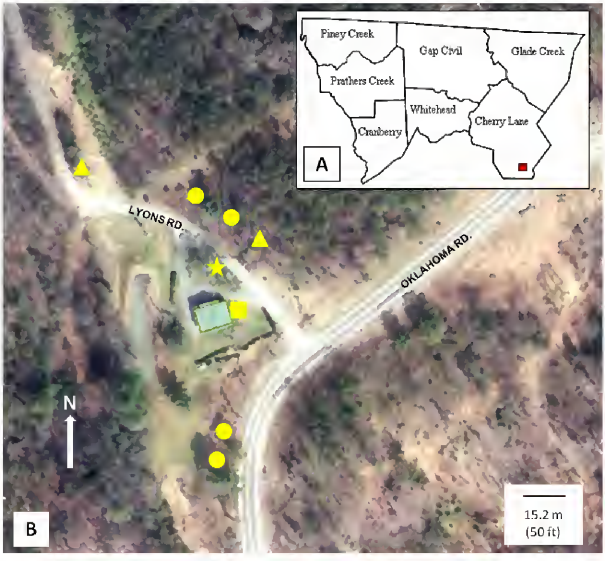

Figure 1. A) Locality of *Abies firma* in Alleghany County, within the Cherry Lane Township (red square), and B) aerial imagery of the site of naturalization. Yellow symbols correspond to parent tree (star), first-year seedlings (squares), 5-8 year old saplings (triangles), and 15-20 year old small trees (circles). Ages of naturalized trees are based on rough estimations.

Figure 2. Branchlets of a vigorous young tree exhibiting different morphological characters than the older, parent tree. Note the sharply pointed, bifid tips of the leaves, as well as their planar orientation.

Figure 3. Image of the parent tree (approximately 22 m tall).

Figure 4. Mature (but unripened) seed cone and branchlets of the parent tree. Note the exserted, non-reflexed bracts of the cone and the short leaves with rounded apices.

Figure 5. Longitudinal section of a seed cone. Note the thin conical rachis.

Figure 6. Adaxial view of a seed scale, displaying young winged seeds.

Figure 7. Abaxial view of a seed scale. Note the oblanceolate bract with a short apical cusp.

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COMMENTS ON *BUDDLEJA LINDLEYANA* (BUDDLEJACEAE) IN TEXAS

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ABSTRACT

Buddleja lindleyana, a non-native species known to occur in east Texas, is recognized as relying on repeated introductions through cultivation and subsequent abandonment for long term persistence.

KEY WORDS: *Buddleja*, Texas, naturalized, persistent.

Buddleja lindleyana Fortune (Buddlejaceae), a native of China, has been mentioned as occurring in Texas since 1913 (Small), yet, other than for generalities, little is known about its occurrence and distribution in the state. Herbarium and field studies have yielded the following information concerning the species in Texas.

Small (1913), which appears to be the initial report of the species in Texas, mentioned the distribution of the species as "Florida to Texas." The inclusion of Texas within the distribution is likely based upon a Montgomery County, Texas, specimen collected in 1909 (see exsiccatae). Cory and Parks (1937) gave the distribution as the Coastal Prairies, while Gould (1962) cited the species as present in the Pineywoods and, in error, considered the species native. In 1970, Correll and Johnston, in their *Manual of the Vascular Plants of Texas*, where it is afforded full specific treatment, gave the following comments: "Roadsides & cult. ground in s.e. Texas, summer-fall, nat. of China, cult. & escapes to become naturalized in the coastal plain from Fla.-Ga.-Tex." Hatch et al. (1990) included the species in their checklist of the state's flora, citing its distribution as the Pineywoods and the Gulf Prairies and Marshes vegetational areas. Johnston (1990) and Jones et al. (1997) included the species in their respective works, but without comment. The species is not included in the *Atlas of the Vascular Plants of Texas* (Turner et al. 2003).

Specimens examined: **Montgomery Co.**: in an old abandoned field, 18-21 Jul 1909, *Dixon 480* (BAYLU photo, NY). **Morris Co.**: Daingerfield State Park, 14 Nov 1998, *Singhurst 7160* (BAYLU). **Travis Co.**: University of Texas campus, Austin, *McKee & Wesley 3840* (TEX).

The Travis County record is presumably cultivated, while the Montgomery County specimen lacks precise location data and information about the nature of the plant's occurrence. The disturbed nature of the habitat (old abandoned field) may indicate that the plant was persistent from cultivation. The Morris County record also seems persistent from cultivation.

Field observations and specimens available for study suggest that the species does not form long-term self-replacing populations, particularly in the Pineywoods vegetational region. Its continued presence relies on cultivation and subsequent long persistence after abandonment. In

Texas, the species is best considered alien or casual alien (categories from Pyšek et al. 2004). In the classification of Nesom et al. (2010), the species is given an invasive index of F3 (woody plants that are few in number, repeatedly introduced and/or long persisting).

Buddleja lindleyana presents neither immediate nor long-term concern as a problematic plant in Texas. Judging from the scattered localities from where it is reported elsewhere in the USA, from Texas, Oklahoma, and Arkansas eastward through the coastal states to North Carolina (USDA, NRCS 2010; Kartesz 2010), the extra-cultivation occurrence of the species probably is similar to that in Texas.

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A NEW VARIETY OF *EUTROCHIUM PURPUREUM* (EUPATORIEAE: ASTERACEAE)

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ABSTRACT

Eutrochium purpureum var. **carolinianum** Sorrie var. nov. is described from the lower piedmont of North Carolina and South Carolina, USA. Its morphological features are compared with the two currently recognized varieties of *E. purpureum*.

KEY WORDS: *Eutrochium purpureum* var. *carolinianum* Sorrie var. nov., Asteraceae, Eupatorieae

Atypical specimens of *Eutrochium purpureum* (L.) E. Lamont (= *Eupatorium purpureum* L.) found in the lower piedmont of North Carolina and South Carolina, represent a distinct and previously unrecognized variety.

Eutrochium purpureum (L.) E. Lamont var. **carolinianum** Sorrie, var. nov. Figs. 1, 2, 3. **TYPE**: **USA**. **North Carolina**. Stanly Co.: open powerline southeast of Stony Hill Church, dominated by grasses and herbs, dry soil derived from mafic rock, common, 14 July 2009, *B.A. Sorrie 12380* (holotype: NCU).

Eutrochio purpureo var. *purpureo* similis sed differt foliis late ovatis ad apices obtusis vel acutis, omnino dense lanulosis abaxaliter, marginibus obtuse serratis, et glandibus acheniorum numerosioribus elongatioribus.

Etymology. The varietal name is derived from the two-state region in which the plants grow. Species formerly treated within *Eupatorium* sect. *Verticillatum* DC. have recently been segregated as the genus *Eutrochium* Raf. (Lamont 2006).

Additonal collections examined. **North Carolina**. Anson Co: upland woods, Pee Dee River, 2.5 mi northeast of Old Sneedsboro, 21 Sep 1956, *Ahles 19432 with Leisner* (NCU). Cabarrus Co.: low woodland border, 1.2 mi west of jct. of NC 27 and US 601 on NC 27, 23 Sep 1956, *Ahles 19754 with Leisner* (NCU). Gaston Co.: wooded stream, 4.1 mi east of Gastonia just north of US 29-74 on Ranlo Road, 17 Sep 1956, *Ahles 18857 with Leisner* (NCU). Montgomery Co.: woodland border, 1.8 mi southeast of Montgomery-Stanly county line (Pee Dee River) on NC 27-73, 6 Jul 1956, *Ahles 16290 with Leisner* (NCU). Moore Co.: narrow powerline on steep slope, George P Road north of Deep River, 24 Jul 2005, *Sorrie 11664* (NCU). Richmond Co.: west of US 1 and east of Pee Dee River, along dirt logging road, disturbed loblolly pine plantation with regenerating hardwoods, 22 Jun 1999, *Sorrie 10175* (NCU). Stanly Co.: upland oak woods, 1.7 mi south of Millingport on Millingport-Lambert Road, 6 Jul 1956, *Ahles 16213 with Leisner* (NCU); north side Jacobs Creek, southwest of SR 1739, frequent in ravine on side of high hill, 17 Oct 2007, *Sorrie 12054* (NCU). Union Co.: roadside, 0.8 mi north-northwest of Waxhaw on NC 16, 14 Jul 1957, *Ahles, 31387 with Haesloop* (NCU); roadside bank on Austin Road (SR 1256), 0.4 mi north of South Carolina line, 12 Jul 2010, *Sorrie 12624* (NCSC). **South Carolina**. Abbeville Co.: roadside, Parsons Mountain, 6 mi south of Abbeville, 29 Jun 1957, *Radford 25939* (NCU). Fairfield Co.: roadside at jct. county routes 22 and 28 west of Woodward, 26 Jun 1957, *Bell 9354* (NCU). Lancaster Co.: rich mesic woods, 40 Acre Rock, NNE of Kershaw, 6 Jun 1957, *Ahles 27456 with Haesloop* (NCU). York Co.: wooded

slope along Sugar Creek on SC 160, east of Fort Mill, 12 Jul 1957, *Ahles 31168 with Haesloop* (NCU).

While synonymizing a number of previously named taxa within *Eupatorium purpureum* L., Lamont (1995, 2006) recognized a widespread variety *E. purpureum* var. *purpureum* in eastern North America plus a midwestern variety *E. purpureum* var. *holzingeri* (Rydberg) E. Lamont. The latter differs from the typical variety in its "densely puberulent to villous" abaxial sides of leaves (Lamont 1995); it ranges from southern Wisconsin to eastern Nebraska and south to northern Arkansas. In var. *holzingeri*, pubescence occurs on the abaxial leaf blade surface as well as on leaf veins and is composed of pale translucent-white, lanulose hairs. Pubescence, if any, on abaxial sides of leaves of var. *purpureum* is restricted to major veins. Lamont (1995, 2006) stated that "West of the Mississippi River (and in the high xeric sand-hills of South Carolina), abaxial leaf faces [of var. *purpureum*] are commonly densely pubescent along the major veins."

	var. *carolinianum*	var. *holzingeri*	var. *purpureum*
Leaf shape	Broadly ovate to broadly elliptical, tip acute to blunt.	Broadly lanceolate to narrowly ovate, tip acuminate to acute.	Broadly lanceolate to narrowly ovate, tip acuminate to acute.
Leaf margin teeth	Short, acute to bluntish, not doubly serrate.	Long, sharply serrate or doubly serrate.	Long, sharply serrate or doubly serrate.
Leaf abaxial surface	Densely soft lanulose on surface and veins.	Densely soft lanulose on surface and veins.	Glabrate, or sparsely lanulose on veins; densely lanulose on veins west of Mississippi River.
Leaf texture	Thickish, +/- rugose.	Thin, not rugose.	Thin, not rugose.
Achene glands at anthesis	Numerous to abundant, distinctly long-papillate.	Sparse to moderate, very short-papillate.	Sparse to moderate, very short-papillate.
Range	Lower piedmont of NC-SC	Midwestern plains	Most of eastern U.S. and s Ont.; encompasses ranges of other 2 vars.

Table 1. Comparison of *Eutrochium purpureum* var. *carolinianum*, var. *holzingeri*, and var. *purpureum*.

The new variety differs in several ways from Lamont's two varieties (Table 1). Note that var. *carolinianum* exhibits significant departures from the norm of *E. purpureum* in leaf shape, marginal teeth morphology, and distribution of vestiture on the abaxial surface. The latter condition is matched only by var. *holzingeri*, which is disjunct by more than 800 km to the west. These differences give the new variety a very different gestalt than plants of var. *purpureum*, which grows sympatrically with var. *carolinianum* but is not known to be syntopic with it. Leaf shape and the somewhat thicker leaf texture are similar to those of *E. dubium* (Willd. ex Poir.) E. Lamont, but that species' leaves are much more rugose, the leaves have three main leaf veins, and it inhabits wetlands of the coastal plain, not dry uplands of the piedmont. *Eupatorium steelei* (E. Lamont) E. Lamont has similarly shaped leaves as var. *carolinianum*, but marginal teeth are sharply serrate, stems are pubescent throughout (vs. glabrous or glabrate below the inflorescence), and it occurs in the montane region of the Southern Appalachians.

The shape and abundance of achene glands of var. *carolinianum* also exhibit significant differences from other varieties of *Eutrochium purpureum*. In the latter, glands are short-papillate or nearly sessile, and often become difficult to see as the achene matures. In the new variety, the glands appear to be more numerous, are distinctly longer, and remain easily visible throughout maturation of the achene.

A small number of specimens show intermediate character states between var. *purpureum* and var. *carolinianum*. These mostly display increased pubescence on leaf abaxial veins and surfaces as compared with var. *purpureum*, but none of them are as densely lanulose as in var. *carolinianum*, nor do they have long-papillate glands on the achenes. Leaf shape and dentition correspond with var. *purpureum* in most specimens. Specimens showing some intermediacy have been seen from Guilford, Iredell, Macon, and Transylvania counties (North Carolina), McCormick County (South Carolina), and Montgomery County (Virginia). Only the McCormick County specimen seems equivocal in identity. The others are outside of the range of var. *carolinianum*, as outlined here, and are identified here as var. *purpureum*.

Phenology. As with sympatric plants of var. *purpureum*, plants of the new variety commence blooming in late June and early July, some three weeks ahead of the two other species of *Eutrochium* in the general region (*E. dubium* and *E. fistulosum* (Barratt) E. Lamont).

Habitat. Plants of the new variety inhabit dry oak-hickory woodlands and openings in them or through them, such as roadsides and powerlines. Canopy species include *Quercus alba*, *Q. stellata*, *Carya glabra*, *C. carolinae-septentrionalis*, and *Acer rubrum*. Understory trees include *Cercis canadensis*, *Ulmus alata*, *Acer leucoderme*, *Cornus florida*, and *Juniperus virginiana*. The range of the new variety lies mostly within the Carolina Slate Belt; local soils are usually derived from mafic metamorphic rocks and are somewhat acidic to circumneutral. Most populations of *E. purpureum* var. *carolinianum* occur in forest openings or clearings, but other populations occur under a dense canopy. In the latter situation, one would expect co-occurrence with var. *purpureum*, but to date the two taxa have not been found growing together (syntopically). This may be an artifact of limited field work, for var. *purpureum* also occurs in virtually all of the counties vouchered for var. *carolinianum*, as evidenced by historical specimens. In any event, a slight shift in habitat preference may contribute to lessened genetic contact.

Phytogeography. Despite its reputation for being floristically uninteresting, the lower Piedmont of the Carolinas (and sometimes extending into adjacent states) features a substantial number of endemic and disjunct taxa adapted to sunny and open habitats, including *Acmispon helleri* (Britt.) Heller, *Helianthus laevigatus* Torr. & Gray, *Helianthus schweinitzii* Torr. & Gray, *Silphium terebinthinaceum* Jacq., *Solidago plumosa* Small, and *Solidago radula* Nutt. Other endemics and disjuncts are adapted to more shaded habitats: *Carex impressinervia* Bryson, Kral, & Manhart, *Euphorbia mercurialina* Michx., *Eurybia mirabilis* (Torr. & Gray) Nesom, and *Phacelia covillei* S. Wats. ex Gray. This suite of taxa suggests an interesting biogeographic history of habitats of the region, which has generated and maintained a distinctive flora.

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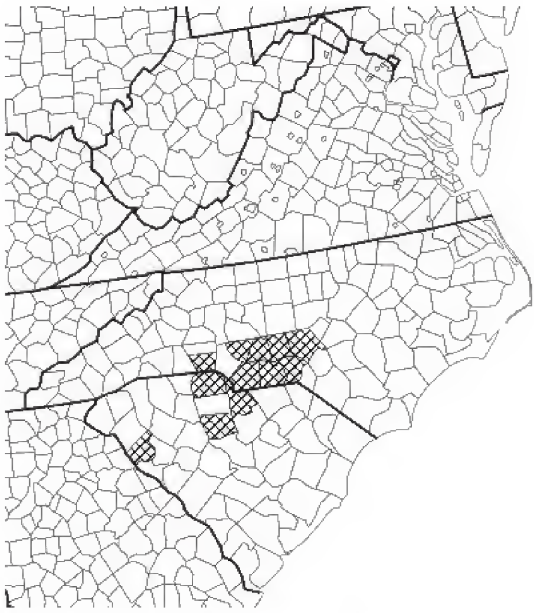

Figure 1. Distribution of *Eutrochium purpureum* var. *carolinianum.* Var. *purpureum* occurs throughout the range of var. *carolinianum* (see text).

Figure 2. Holotype of *Eutrochium purpureum* var. *carolinianum*.

Figure 3. Leaves of *Eutrochium purpureum* var. *carolinianum* showing densely soft-lanulose abaxial surface and veins and thickish, rugose texture.

O'Kane, S.L., Jr., K.D. Heil, and G.L. Nesom. 2010. Variation in *Erigeron grandiflorus* (Asteraceae: Astereae) in southwestern Colorado. Phytoneuron 2010-44: 1–6.

VARIATION IN *ERIGERON GRANDIFLORUS* (ASTERACEAE: ASTEREAE) IN SOUTHWESTERN COLORADO

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ABSTRACT

In alpine tundra and fell fields in southwestern Colorado (San Juan Co.), individuals of *Erigeron grandiflorus* of extremely reduced size are common and abundant but previously undocumented in that size range — with stems 2–20 mm tall and involucres 5–7 mm wide producing 17–50 ray florets. The plants are monocephalous alpine perennials. A revised description of the species and photos of size variants, including the dwarf-like plants, are provided.

KEY WORDS: *Erigeron grandiflorus*, Astereae, variation, Colorado

The concept of *Erigeron grandiflorus* Hooker has recently been broadened to include plants previously identified as *E. simplex* Greene (Nesom & Murray 2004; Nesom 2006). Spongberg (1971) separated *E. simplex* (diploid) from *E. grandiflorus* (triploid, termed by Spongberg "the southern alpine race of *E. grandiflorus*") but distinguished them only by quantitative and broadly overlapping morphological features, with *E. grandiflorus* in the larger range. Nesom and Murray (2004) noted that practical separation of *E. simplex* from *E. grandiflorus* is arbitrary, even among collections identified by Spongberg, and adoped the earlier epithet to cover the whole range of variation (*E. grandiflorus* 1834 vs. *E. simplex* 1897).

We had an opportunity in 2010 to study populations of *Erigeron grandiflorus* in San Juan County, Colorado, and here present observations that extend the range of variability in the species toward smaller extremes than previously recorded. Figures 1–6 show plants from Stony Pass and the habitat, ca. 6.5 air miles east-southeast of Silverton, at an elevation of ca. 12,500 feet (*Heil 32,742* with O'Kane and Nesom). Measurements toward the smaller extremes are from plants observed and collected at Stony Pass and at Lake Emma (*Heil 32,743* with O'Kane and Nesom), ca. 5 air miles NE of Silverton, both on 22 July 2010.

Plants of *Erigeron grandiflorus* are perennials arising from a short, fibrous-rooted rhizome and characterized by a monocephalous habit, subscapose stems, entire leaves mostly in a basal rosette, and villous involucres. Essentially, we observed that in small areas on fell fields between 12,000 and 12,700 feet elevation, *E. grandiflorus* occurs in abundance as plants 2–20 mm tall, the shortest with heads barely above ground level. These plants also produce very small leaves (4–12

mm long) and small heads (involucres 5–7 mm wide, phyllaries 4–5 mm long) with rays few (17–50) and short (4–5 mm long) often in a single series, short disc corollas (2–2.3 mm long), and short cypselae (1.2–1.7 mm long). In plants at the upper range of height and head size, ray florets were produced in greater number and always in two series. Ranges of variation also appear to be continuous for other characters, but the larger plants are relatively fewer and in deeper soil at the edges of the fell areas.

Erigeron humilis Graham grows in abundance at both study sites but does not occur in the very shallow soil of the fell field with the smallest plants of *E. grandiflorus*, nor did we encounter dwarf-like plants of *E. humilis*. On the margins, in slightly deeper soil, and further outward, both *Erigeron* species grew intermixed. *Erigeron humilis* at Stony Pass: *Heil 32,744* with O'Kane and Nesom.

We suspect that the previous lack of accounting for the lower size range in *Erigeron grandiflorus* is more reflective of sampling bias than occurrence in nature, and individuals similarly reduced in size may occur over the range of the species. In any case, to encounter perennial plants of Asteraceae of such small size, in any type of habitat, is unusual in our experience.

Revised description of *Erigeron grandiflorus*.

Plants perennial, from short, horizontal or erect, fibrous-rooted rhizomes, caudex essentially unbranched or with short, thick branches. **Stems** 0.2–25 cm high, erect to basally decumbent-ascending, sparsely to moderately pilose to villous-hirsute, variably stipitate-glandular over whole or part of stem, sometimes essentially eglandular. **Leaves** basal and cauline, basal persistent, oblanceolate to obovate or spatulate, apically rounded, 1-nerved, (0.4–)1–6(–9) cm long, (1.5–)2–6(–14) mm wide, entire, cauline 1–3 on the proximal 1/4–1/2, quickly or gradually reduced upward, not subclasping, glabrous or glabrate to sparsely hirsutulous, villous, or sparsely strigose, sometimes sparsely glandular. **Heads** 1; involucres campanulate-turbinate, 4–8(–10) mm high, 5–20 mm wide; phyllaries in 2–3 subequal series, narrowly oblong-lanceolate, green or purplish, moderately to densely woolly-villous, sometimes with reddish crosswalls, minutely glandular at least near the tips, tips loose. **Ray florets** 17–130 in 1 or 2 series, corollas 4–11(–15) mm long, laminae white to blue, pink, or purplish, loosely coiling or not. **Disc corollas** 2–4(–5) mm long, narrowly tubular-funnelform, throat not indurate or inflated. **Cypselae** oblanceolate-oblong in outline, ca. 1.2–2.4 mm long, 2-nerved, sparsely strigose; pappus of (7–)10–22 bristles, with an outer series of narrow scales or a few inconspicuous setae. $2n = 18, 27$.

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Nesom, G.L. and D.F. Murray. 2004. Notes on North American arctic and boreal species of *Erigeron* (Asteraceae: Astereae). Sida 21:41–58.

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Figure 1. Habitat of dwarf-like *Erigeron grandiflorus* at Stony Pass.

Figure 2. Dwarf-like plants of *Erigeron grandiflorus* at Stony Pass.

Figure 3. Dwarf-like plant of *Erigeron grandiflorus* at Stony Pass. Peduncle ca. 2 mm long.

Figure 4. Array of *Erigeron grandiflorus* individuals from fell field and alpine tundra habitat at Stony Pass showing trend toward extreme reduction in size. Peduncles ca. 2–120 cm in length.

Figure 5. Middle-sized plants of *Erigeron grandiflorus* at Stony Pass. Peduncles 8–9 cm in length

Figure 6. Very small plants of *Erigeron grandiflorus* at Stony Pass. Peduncles 3–5 cm long; rays 17–25 in a single series

TAXONOMY AND DISTRIBUTION OF *DALEA WRIGHTII* (FABACEAE)

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ABSTRACT

Dalea wrightii A. Gray is treated as a widespread and variable species consisting of two infraspecific taxa: var. *wrightii* and var. *warnockii* (Tharp & Barkley) B.L. Turner. The former is a more western element occurring in southern Arizona, southern New Mexico, western trans-Pecos Texas, northeastern Sonora, Chihuahua, and western Coahuila. Var. *warnockii* is largely confined to the easternmost trans-Pecos Texas, eastern Coahuila, and closely adjacent Nuevo León, Mexico. The two taxa appear to intergrade in regions of near-contact, hence their treatment at varietal rank. Morphological characters that mark the taxa are discussed, and a map showing their distribution is provided.

KEY WORDS: *Dalea, D. wrightii*, Texas, New Mexico, Arizona, Mexico

Barneby (1977), in his masterful treatment of *Dalea* for North American, treated *D. wrightii* as monotypic, noting that the closely related *Dalea subulicola* T. Brandegee (including *Parosela warnockii* Tharp & Barkley) seemed unworthy of nomenclatural recognition and that the present author concurred with his taxonomy, which was so at the time (Turner 1959). Subsequently, however, in my Atlas of the Vascular Plants of Texas (Turner et al. 2003) I recognized *P. subulicola* as distinct and treated and mapped it as a valid taxon at varietal rank, using as the basionym the Texan eponymee (Barton Warnock) and authors Benjamin Tharp and Fred Barkley — *D. wrightii* var. *warnockii*. The present paper further documents that taxonomy.

DALEA WRIGHTII A. Gray, Pl. Wright. 1: 49. 1850. *Parosela wrightii* (A. Gray) Vail, Bull. Torrey Bot. Club 24: 16. 1897. **TYPE: USA. Texas**. Jeff Davis Co.: eastern part of county near Barilla Springs, Aug 1849, *C. Wright 134* (holotype: GH).

Barneby (1977) has given an excellent description of the species and this need not be repeated here. The following will help delimit the varieties concerned:

KEY TO VARIETIES

1. Leaflets mostly 2–3 times as long as wide, their apices mostly acute or rarely narrowly obtuse; western Coahuila and western Trans-Pecos, Texas, westward to Arizona and Sonora .... var. **wrightii**
1. Leaflets mostly 1–2 times as long as wide, their apices mostly obtuse; eastern trans-Pecos Texas, Coahuila, and western Nuevo León ..... var. **warnockii**

Var. WRIGHTII Fig. 1.

This is a relatively distinct taxon throughout its range, but occasional plants approach var. *warnockii*, especially in southeastern Chihuahua, across from the trans-Pecos region of Texas (e.g., *Stewart 612, Stewart 992,* TEX).

Dalea parrasana T. Brandegee superficially resembles *var. wrightii*, but the two taxa are readily distinguished by their floral features, these brought to the fore by Barneby (1977). *Dalea*

wrightii var. *warnockii* occurs with *D. parrasana* in the Parras region of southern Coahuila (the two taxa mounted on the same sheet [*Henrickson 6160*, TEX]). It is possible that the occasional hybrid between these might occur.

In short, *Dalea wrightii* var. *wrightii* and var. *warnockii* appear to be distinct regional taxa (Fig. 3), the former more western, the latter more eastern, with occasional signs of intergradation along regions of near-contact.

Var. WARNOCKII (Tharp & Barkley) B.L. Turner, Sida, Bot. Misc. 24: 7. 2003. *Parosela warnockii* Tharp & Barkley, Anales Esc. Nac. Ci. Biol. 4: 284. 1946. **TYPE: USA. Texas.** Pecos Co.: [between] Fort Stockton [and] Sheffield, 3 Jun 1940, *B.C. Tharp s.n.* (holotype: TEX). Fig. 2.

Dalea subulicola T. Brandegee, Univ. Calif. Publ. Bot. 4: 179. 1911

The most obvious difference of this variety from the typical taxon is that of leaf shape, as noted in the above key to varieties. Barneby also noted that in var. *warnockii*, the vestiture appears to be more nearly tomentose, which is so for most of the plants occurring in the USA and in much of Mexico. Nevertheless, seemingly intermediate plants may be found in southern Coahuila (e.g., 5 mi W of Saltillo along route 60, *Correll & Johnston 21391* [LL]; El Kelso, Ramos Arizpe, gypsum hillside, *Hinton et al. 25972* [TEX]). Whether such intermediates suggest past or current hybridization is moot.

ACKNOWLEDGEMENTS

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Figure 1. *Dalea wrightii* var. *wrightii* (from near the type locality, Jeff Davis Co., Texas).

Figure 2. Holotype of *Dalea wrightii* var. *warnockiii* (= *Parosela warnockii*) (Pecos Co.Texas).

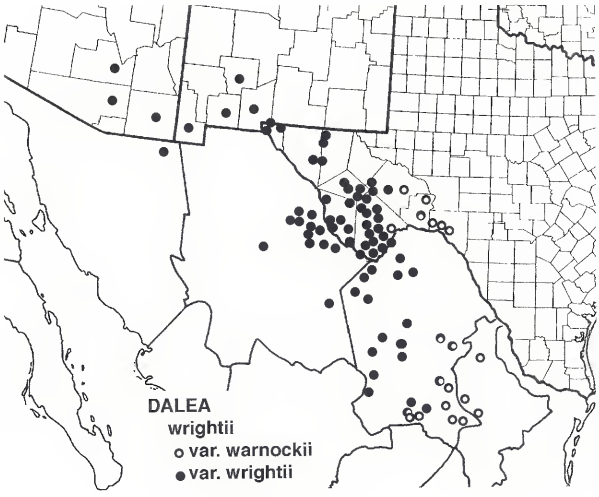

Figure 3. Distribution of the two varieties of *Dalea wrightii*.

Nesom, G.L. 2010. Taxonomy of the *Glandularia bipinnatifida* group (Verbenaceae) in the USA. Phytoneuron 2010-46: 1–20. Mailed 12 October 2010.

TAXONOMY OF THE *GLANDULARIA BIPINNATIFIDA* GROUP (VERBENACEAE) IN THE USA

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ABSTRACT

Study of plants variously identified within the *Glandularia bipinnatifida* group indicates that the USA entities are appropriately recognized within six species: *G. bipinnatifida* (Nutt.) Nutt., *G. wrightii* (A. Gray) Umber, *G. chiricahuensis* Umber, **Glandularia latilobata** (Perry) Nesom, comb. et stat. nov., **Glandularia longidentata** (Perry) Nesom, comb. et stat. nov., and **Glandularia pubera** (Greene) Nesom, comb. nov. These species are distinguished in a key, described, and mapped. Summaries of typification are provided. *Glandularia gooddingii* is sometimes confused with these species and its distinction is discussed.

KEY WORDS: *Glandularia bipinnatifida*, Verbenaceae, taxonomy

The taxonomy of *Glandularia bipinnatifida* (Nutt.) Nutt. and its close relatives has been studied by Perry (1933), Moldenke (1962–1965), Umber (1979, 1980), Turner (1998, 1999), and Turner and Powell (2005) but identification of these plants has remained problematic. In connection with the development of an overview and taxonomic treatment for the Flora of North America North of Mexico (FNANM), I have reviewed the nomenclatural types and variation patterns in these plants and offer yet another taxonomic perspective.

Concepts of species and application of names in the *Glandularia bipinnatifida* group have varied both widely and subtly. Details regarding some of the recent usage are discussed under the pertinent species. In general, Perry's study provided an excellent beginning but typological identifications blurred species boundaries. Even Umber's treatment of this group seems to have been marked by typology and over-inclusiveness, as he described segregates that I am not able to affirm and he overrepresented the morphological and geographical extent of *G. bipinnatifida*. Turner nomenclaturally linked USA entities to a Mexican taxon, but my study indicates that the more northern species are discrete in morphology and geography, thus not calling for formal taxonomic connections with those further south.

To be complete, however, the present study would need to give detailed attention to the central Mexico representatives of the group, which have been abundantly collected. Umber (1979) and Peralta (1985) treated all of the Mexican plants of this group broadly as *Glandularia* (or *Verbena*) *bipinnatifida*, but there are geographical elements among them. *Verbena ciliata* Benth. [1839] = *Glandularia* (*Verbena*) *ciliata* (Benth.) Botta is the oldest name among the Mexican plants of this group.

In the present study, which centers on plants of the FNANM flora area, I have attempted to delimit taxa and their geographical distributions and then to find the correct names. An advantage of the protracted nature of this study (begun in 2008), looking and then looking again at various sets of specimens, is that discrete geographic boundaries have become more evident. Perception of ranges of variability also underlies, at least in part, differences with earlier studies in interpretation of nomenclatural types.

Glandularia racemosa (Eggert) Umber is perhaps a closely related member of this group, but its annual habit and small white corollas make it relatively simple to identify consistently. *Glandularia gooddingii* (Briq.) Solbrig produces leaves that vary from unlobed with merely toothed margins to leaves that are deeply dissected with linear lobes — the latter are sometimes confused with plants of the species treated here. *Glandularia racemosa* is included in the key but is not among the species described and mapped; identification of *G. gooddingii* is discussed in a separate section below.

KEY TO THE SPECIES

1. Calyces eglandular to sparsely glandular with sessile to subsessile glands.

2. Floral bracts shorter to longer than the calyces; corolla tubes 9–14 mm, limbs mostly 9–15 mm in diam.; central USA..... **Glandularia bipinnatifida**
2. Floral bracts shorter than the calyces; corolla tubes 7–13, limbs 6–10(–12) mm in diam.; Arizona and New Mexico.

3. Stems decumbent to ascending or ascending-erect, 12–40 cm; calyces 5–7 mm; corollas purplish to blue or lavender, tubes 7–11, limbs 6–9 mm in diam.; habitats at 1300–2500 m ..... **Glandularia latiloba**
3. Stems ascending to erect, 20–80 cm; calyces 8–10 mm; corollas usually pink to purplish pink, less commonly violet, tubes 10–13 mm, limbs 7–10(–12) mm in diam.; habitats at 2300–2800(–3000) m ..... **Glandularia chiricahensis**

1. Calyces densely stipitate-glandular.

4. Plants annual; corollas white, sometimes bluish tinged; corolla tubes 6–7.5 mm, limbs (5.5–)6–9 mm in diam. ..... **GLANDULARIA RACEMOSA**
4. Plants annual or perennial; corollas pink to purplish or blue; corolla tubes 7–15 mm, limbs 7–12 mm in diam.

5. Stems densely hirsute to pilose-hirsute or hirsutulous, at least some of the hairs deflexed; corollas consistently bright pink to purplish pink and drying similarly, tubes 12–15 mm, limbs 8–12 mm in diam. ..... **Glandularia pubera**
5. Stems stiffly hirsute with hairs spreading at right angles; corollas usually drying purple, purple to bluish or pinkish when fresh, tubes 7–12 mm, limbs 7–12 mm in diam.

6. Plants perennial; stems decumbent-ascending to ascending-erect or erect; leaves 1–2-pinnatifid, midstem ovate to lanceolate-ovate in outline, 2–4(–5) cm; corolla tubes 8–12 mm; western Texas to New Mexico and Colorado ..... **Glandularia wrightii**
6. Plants annual; stems procumbent to decumbent-ascending,; leaves 2–3-pinnatifid, midstem broadly ovate to deltate in outline, 1.5–3(–4) cm; corolla tubes 7–9 mm; south Texas (Rio Grande plains) ..... **Glandularia longidentata**

GLANDULARIA BIPINNATIFIDA (Nutt.) Nutt., Trans. Amer. Philos. Soc., n.s. 5: 184. 1836. *Verbena bipinnatifida* Nutt., J. Acad. Nat. Sci. Philadelphia 2: 123. 1821. **TYPE: USA. Arkansas**. [Red River], *T. Nuttall s.n.* (probable holotype: PH digital image!; isotype: GH). Umber (1979) indicated that he saw an isotype at NY, but I did not find one there nor is one included in the NY online type database.

Verbena demareei Moldenke, Amer. Midland Naturalist 24: 752. 1940. **TYPE: USA. Arkansas**. Clark Co.: P.O. Okolona, chalk and marl ditches, 350 ft, 30 Jun 1938, *D. Demaree 17198* (holotype: NY?; isotypes: GH, MO!, NY digital image!). The NY specimen that is pictured

online (NY 00138170) was annotated by Moldenke in 1941 as an isotype; Moldenke (1962, p. 210), however, noted that the holotype is deposited at NY.

Plants perennial, sometimes annual. **Stems** prostrate, decumbent, ascending, or ascending-erect, sometimes adventitiously rooting on the proximal decumbent portions, 5–30(–50) cm, moderately to densely hirsute, eglandular. **Leaves** ovate to broadly ovate in outline, membranaceous, blades 1.2–2 times longer than wide, 1–2-pinnatifid, 3-parted, or deeply incised, ultimate segments linear to oblanceolate, midstem 1–6 cm, hispid-hirsute to strigose or hirtellous, eglandular; petioles 5–15(–20) mm. **Inflorescence** elongating to 5–15(–20) cm in fruit; floral bracts shorter to longer than the calyces. **Calyces** 7–10 mm, hispid and strigose, eglandular or sometimes sparsely stipitate-glandular. **Corollas** purple, lavender, or bluish, rarely white, tubes 9–14 mm, limbs mostly 9–15 mm in diam. **Nutlets** cylindric, 2.5–3.2 mm, not broadened at the base, black, commissure not reaching the apex, 1/3–1/2 as wide as the nutlet apex, apical appendage absent. 2n = 30.

Flowering Apr–Jun(–Oct). Prairies, ridges, bluffs, limestone outcrops, gypsum hillsides, low woods, roadsides, fencerows; 50–600 m; Ala., Ark., Colo., Ga., *Ind., *Iowa, Kans., *Ky., La., Miss., Mo., Nebr., Okla., S.Dak., Tex., *Wis., Wyo.; Mexico (Coahuila). Map in Fig. 4. *=cultivated?

I have seen only two collections of *Glandularia bipinnatifida* sensu stricto from Mexico (as mapped here on Fig. 4): **Coahuila**: Mpio. Villa Acuña, limestone hill near Santo Domingo, 3 Jul 1936, *Wynd & Mueller 450* (MO); Mpio. Villa Acuña, Rancho El Rincon, on SW margin of Serranias del Burro (part of Sierra del Carmen), ca. 80 km SE of Big Bend Natl. Park, Texas, 1400-2100 m, 22 Jun 1991, *Ruiz 54* (TEX).

The Mississippi-Alabama plants consistently have minutely stipitate-glandular calyces (vouchers seen from Scott and Oktibbeha cos. — Miss; Autauga, Dallas, Greene, Hale, Lowndes, Marengo, Montgomery, Pickens, Sumter, Wilcox cos. — Ala). I have not seen a voucher for the extreme eastern outlyer in Georgia (Houston Co., see Fig. 4; ranked S1 by the Georgia Natural Heritage Program), but presumably it is similar to those in Alabama and eastern Mississippi. The population system east of the Mississippi River might be recognized at varietal rank, emphasizing its geographical distinction, but the sparse glandularity occurs sporadically through western populations and such a minor and quantitative distinction hardly seems to justify formal recognition.

Turner (1998, 1999) treated *Glandularia bipinnatifida* broadly to include several putatively intergrading geographic varieties. Within his concept of *G. bipinnatifida* var. *ciliata* (Benth.) Turner (= *Glandularia ciliata*) were three entities treated here as distinct species: *G. longidentata*, *G. wrightii*, and *G. pubera*. In the concept here, *Glandularia ciliata* sensu stricto is a species of central Mexico (southern Durango, Nayarit, and Jalisco eastward to San Luis Potosí, Hidalgo, Estado México, and Puebla) and does not appear to be genetically continuous with the more northern taxa.

Umber's concept of *Glandularia bipinnatifida* (1979, 1980) was even broader. Within it, he included *G. ciliata* sensu stricto and plants identified here as *G. latilobata*, *G. longidentata*, and *G. wrightii*. He was mostly unable to find any meaningful geographic trends in morphology, but he did, however, find "chemical races"(based on flavonoid profiles) that bear some correspondence to taxa recognized in the present study.

GLANDULARIA WRIGHTII (A. Gray) Umber, Syst. Bot. 4: 92. 1979. *Verbena wrightii* A. Gray, Synopt. Fl. N. Amer. 2: 337. 1878. **TYPE**: **USA. Texas**. [El Paso Co.: Franklin Mountains] Mountains near Fronteras, 22 Mar 1852, *C. Wright 1504* (holotype: GH! — Fig. 1 in the present report; isotypes: F digital image!, NY! digital image!; probable isotype: MO!).

Verbena ambrositifolia Rydb. ex Small, Fl. S.E. U.S., 1011, 1327. 1903. **TYPE**: **USA. Colorado**. Otero Co.: Rocky Ford, 8 Jun 1900, *G.E. Osterhout s.n.* (holotype: NY!, digital image!).

Verbena wrightii forma *albiflora* Moldenke, Phytologia 11: 497. 1965. **Type**: **USA. Texas**. Brewster Co.: Alpine, Sul Ross College campus, 2 Apr 1936, *B.H. Warnock 44* (holotype: NY; isotype: US digital image!).

Plants perennial. **Stems** decumbent-ascending to ascending-erect or erect, (15–)25–60 cm, stiffly hirsute with hairs spreading at right angles, eglandular or very sparsely stipitate-glandular. **Leaves** ovate to lanceolate-ovate in outline, membranaceous, blades 1.2–2(–2.5) times longer than wide, 1–2-pinnatifid, ultimate segments mostly lanceolate to oblanceolate, midstem mostly 2–4(–5) cm, hirsute-strigose, eglandular; petioles 4–15 mm. **Inflorescence** elongating to 2–5(–11) cm, in fruit; floral bracts shorter than to nearly equalling the calyces. **Calyces** 6–8 mm, sparsely to moderately hirsute-pilose, densely minutely stipitate-glandular. **Corollas** mostly purple-pink, rose-purple, purple, or lavender-blue, tubes 8–12 mm, limbs 7–12 mm in diam. **Nutlets** cylindric, 2.5–3.2(–3.5) mm, slightly broadened at the base, black, commissure not reaching the apex, 1/3–1/2 as wide as the nutlet apex, apical appendage absent. $2n = 30$.

Flowering Apr–Sep. Creosote bush, creosote bush-acacia-mesquite, shrubland, juniper, pine-juniper, pine-juniper-oak, limestone slopes, grasslands, roadsides, fencerows, rocky hillsides, lava beds, gravelly banks, arroyos; 1300–2400 m; Colo., N.Mex., Tex.; Mexico (Chihuahua, Coahuila, Durango, Nuevo León, Zacatecas). *Glandularia wrightii* occurs in Oklahoma — in Cimarron Co., in the western tip of the panhandle. Map in Fig. 5.

In the interpretation here, the type specimen of *Glandularia wrightii* does not correspond to the morphological concept adopted by Umber (1979) and by Turner and Powell (2005). What they identified as *G. wrightii* is instead identified here as *G. pubera*. Measurements from the holotype of *G. wrightii* (Fig. 1): calyces 7–8 mm long, lobes linear-filiform; corollas "light purple" (fide A. Gray), tubes 8–11 mm long, limbs ca. 8–10 mm in diam., lobes 2.5–3.5 mm wide; floral bracts and calyces hirsute, densely stipitate-glandular; stems sparsely glandular, hirsute-hirsutulous, hairs spreading at right angles, 0.2–0.9 mm long.

The southern boundary of *Glandularia wrightii* is not determined with certainty in the present study. I have mapped the species as far south as northern Zacatecas (Fig. 5), where it apparently becomes sympatric with *G. ciliata*, but this needs detailed study and documentation. Turner saw only a single taxon, which he recognized as *G. bipinnatifida* var. *ciliata*; if his biological interpretation is correct, *Verbena ciliata* Benth. would be the oldest name for the species.

Glandularia wrightii along the eastern edge of its range is parapatric to slightly sympatric with typical *G. bipinnatifida* (Figs. 4, 5). The two taxa both a hexaploid and clearly are very similar in morphology but the differences (especially the vestiture) as outlined in the couplet below are consistent and sharply defined.

1. Inflorescence elongating to 2–5(–11) cm, in fruit; calyces sparsely to moderately hirsute-pilose, densely minutely stipitate-glandular; corolla tubes 8–12 mm, limbs 7–12 mm in diam. ..... **Glandularia wrightii**

1. Inflorescence elongating to 5–15(–20) cm in fruit; calyces hispid and strigose, eglandular or sometimes sparsely stipitate-glandular; corolla tubes 9–14 mm, limbs mostly 9–15 mm in diam. ..... **Glandularia bipinnatifida**

Turner (1998, p. 5) observed that *Glandularia bipinnatifida* "is relatively uniform over most of its distribution, but just west of the Pecos River in trans-Pecos Texas it appears to intergrade over a relatively short distance in [*G. wrightii*]. … Once the Pecos River is reached going eastward (only ca. 15 mi or so), the populations of [*G. wrightii*] are replaced by [*G. bipinnatifida*]." In Pecos County, where they are sympatric within about a 50-mile radius of Fort Stockton (west of the Pecos

River), intermediates have been noted between the two (*Turner 97-33*, *97-43*, *97-79*; all TEX); at other sites in the same area, they appear to grow together without intermediacy (e.g., *Turner 24-53*, typical *G. wrightii*, observed to be growing with typical *G. bipinnatifida*). Even in view of these hybrids in the narrow zone of sympatry/parapatry, the morphological distinction between the two appears to be essentially discontinous and in justification of their treatment as separate species. Still, it is a subjective judgement and their treatment as conspecific varieties also might be justified in view of the hybridization.

GLANDULARIA LONGIDENTATA (L.M. Perry) Nesom, comb. et stat. nov. *Verbena ciliata* Benth. var. *longidentata* L.M. Perry, Ann. Missouri Bot. Gard. 20: 331. 1933. **TYPE**: **Mexico**. **Tamaulipas**. Matamoros, Apr 1836, *J.L. Berlandier 3020* (holotype: MO!, digital image!; isotypes: GH!, NY-digital image!).

Plants annual. **Stems** branching profusely from crown, procumbent to decumbent-ascending, 1.5–3(–4) cm, pilose to hirsute or hispid-hirsute, eglandular. **Leaves** broadly ovate to deltate in outline, membranaceous, blades 1.5–2 times longer than wide, 2–3-pinnatifid, ultimate lobes lanceolate to oblanceolate, midstem 1.5–3(–4) cm, hirsute to hirsute-strigose, eglandular, rarely sparsely stipitate-glandular; petioles 4–10 mm. **Inflorescence** elongating to 2–5(–7) cm in fruit; floral bracts shorter than the calyces. **Calyces** 6–7 mm, hispid-hirsute, densely minutely stipitate-glandular. **Corollas** rose-lavender, blue-lavender, or purple to violet, tubes 7–9 mm, limbs 8–11 mm in diam. **Nutlets** subcylindric, 2.2–3.2 mm, broadened at the base, black, commissure not reaching the apex, 1/3–1/2 as wide as the nutlet apex, apical appendage absent. $2n = 30$ (as inferred from reports of counts of "*G. bipinnatifida*" from Duval and Hidalgo counties; Lewis & Oliver 1961).

Flowering Dec–Apr. Fields, vacant lots, roadsides, ditch banks, low hills, low plains, thorn scrub, saline flats, sand, sandy loam, silty clay, caliche, marl; 2–60(–500) m; Texas; Mexico (Nuevo León, Tamaulipas). Map in Fig. 6.

Glandularia longidentata is essentially parapatric with typical *G. bipinnatifida* (Figs. 6 and 4) but both species have been collected in Maverick, McMullen, Nueces, and San Patricio counties. I have not seen an unequivocal intermediate, though occurrence of hybrids would not be unexpected. The former is distinct in its annual duration, consistently decumbent-ascending stems and radiating from the base (producing a bowl-shaped habit), shorter, relatively broader, and more dissected leaves, and shorter corolla tubes.

Perry's concept of *Verbena ciliata* var. *longidentata* corresponds to the taxon treated here at specific rank. Umber (1979) did not recognize it as distinct, treating the name as a synonym of his broadly defined *Glandularia bipinnatifida*. Turner (1998) mapped the population system of *G. longidentata* as part of *G. bipinnatifida* var. *ciliata*, showing its distinct range in Texas — similar to the distribution shown here in Fig. 6 and (also as interpreted here) similar in its essential parapatry with typical *G. bipinnatifida*.

Collections examined from **Mexico**. **Nuevo León**. 2 mi N of Sabinas Hidalgo, sandy loam bottom, 26 Mar 1944, *Barkley et al. 14512* (MO); 16 km W of Sabinas Hidalgo, Villaldama road, among large rocks, 7 Apr 1962, *Dominguez & McCart 8263* (BRIT); 2 mi N of Sabinas Hidalgo, sandy loam bottom, 26 Mar 1944, *Heard et al. 14512* (TEX); Sabinas Hidalgo, 16 Aug 1937, *Kenoyer s.n.* (MO); 12 mi W of Monterrey, rock and gravel in xerophytic canyon, 27 Feb 1944, *Painter et al. 14281* (TEX); 16 mi S of Nuevo Laredo on Hwy 85, 19 Mar 1967, *Wilson 12167* (TEX). **Tamaulipas**. 22 mi S of Matamoros, black clay, 21 Mar 1964, *Montemayor 31* (BRIT, TEX); 22 mi S of Matamoros, Natl. Hwy 101, sandy soil, 21 Mar 1964, *Serna 34* (BRIT).

GLANDULARIA LATILOBATA (L.M. Perry) Nesom, comb. et stat. nov. *Verbena bipinnatifida* Nutt. var. *latilobata* L.M. Perry, Ann. Missouri Bot. Gard. 20: 325. 1933. *Glandularia bipinnatifida* (Nutt.) Nutt. var. *latilobata* (L.M. Perry) B.L. Turner, Lundellia 2: 63. 1999. **TYPE**: **Mexico**. **Sonora**. Between San Pedro and Fronteras, 20-24 Sep 1890, *C.V. Hartman 906* (holotype: GH!).

Plants perennial. **Stems** decumbent to ascending or ascending-erect, 12–40 cm, hirsute and hirtellous, eglandular or sparsely stipitate-glandular. **Leaves** ovate to obovate in outline, membranaceous, blades 1.3–2 times longer than wide, 1–2-pinnatifid, ultimate lobes linear to oblanceolate, midstem 2–4 cm, hirsute to strigose-hirsute, eglandular or very sparsely stipitate-glandular; petioles 4–10 mm. **Inflorescence** elongating to 2–4(–6) cm in fruit; floral bracts shorter than the calyces. **Calyces** 5–7 mm, hirsute and strigose, eglandular to sparsely sessile to subsessile glandular. **Corollas** purplish to blue or lavender, tubes 7–11, limbs 6–9 mm in diam. **Nutlets** subcylindric, 2.5–3.2, broadened at the base, black, commissure not reaching the apex, 1/3–1/2 as wide as the nutlet apex, apical appendage absent. 2n = unknown.

Flowering (Apr–)Jun–Sep. Pinyon-juniper, pine-oak, oak, alluvial benches, roadsides; 1300–1800(–2300) m; Ariz., N.Mex.; Mexico (Chihuahua, Durango, Sonora). Map in Fig. 7.

Calyces of *Glandularia latilobata* characteristically appear eglandular but close inspection may show the presence of minute, translucent, sessile to subsessile glands. Arizona plants with stipitate glands and tentatively identified as *G. latilobata* should be reexamined for the possibility that they are instead *G. gooddingii* with dissected leaves. In Socorro Co., New Mexico, where *G. latilobata* is sympatric with *G. wrightii* (with densely stipitate-glandular calyces), the contrast in vestiture usually provides good confidence in their distinction. The flowers of *G. wrightii* also are larger than those of *G. latilobata* although the differences are overlapping.

Umber (1979) treated this entity among many synonyms of *Glandularia bipinnatifida* var. *pinnatifida*, while Turner (1999) followed the earlier observation of Perry and recognized it as *G. bipinnatifida* var. *latilobata* (although he broadened the concept by including *G. chiricahuensis* as a synonym). With Perry and Turner, I agree that "latilobata" is distinct, but its distribution (Fig. 7) is disjunct from that of typical *G. bipinnatifida*. At the southern end of its distribution in Mexico, *G. latilobata* apparently is sympatric with the Mexican endemic *G. ciliata*.

Turner's rationale for treating *Glandularia latilobata* as conspecific with *G. bipinnatifida* was explicit (p. 64): "This taxon is similar to [*G. bipinnatifida*] var. *ciliata* but lacks the glandular pubescence of that taxon. It grades into var. *ciliata* to the south and southeast." His distribution map, however, shows only a single intermediate symbol where their ranges contact, and my own observations suggest that they do not intergrade to the extent that would indicate their appropriate treatment as conspecific.

GLANDULARIA CHIRICAHENSIS Umber, Syst. Bot. 4: 92. 1979. **TYPE**: **USA**. **Arizona**. Cochise Co.: Chiricahua Mountains, Rustler's Park, 19 Aug 1973, *R. Umber 640* (holotype: GH!; isotypes: ARIZ, MO!, NMC, NY, UC).

Verbena ambrosiifolia Rydb. ex Small forma *eglandulosa* L.M. Perry, Ann. Missouri Bot. Gard. 20: 331. 1933. **TYPE**: **USA**. **New Mexico**. Grant Co.: vicinity of Silver City, Fort Bayard, Santa Rita, Fierro, the Mimbres Valley and East Canyon tributary to it, and on the G.O.S. Ranch, in canyons within 10 mi of the ranch house, Hannover [lft], 1 Aug 1911, *J.M. Holzinger s.n.* (holotype: MO!).

Plants perennial. **Stems** ascending to erect, 30–80 cm, hirsute-villous with flattened hairs, eglandular. **Leaves** ovate to broadly ovate in outline, membranaceous, blades 1.2–2 times longer than

wide, usually 1–2(–3)-pinnatifid, ultimate segments lanceolate to oblanceolate, midstem 3.5–7 cm, strigose on both surfaces; petioles 5–15 mm. **Inflorescence** elongating only slightly in fruit to 2–4(–5) cm; floral bracts slightly shorter to longer than the calyces. **Calyces** 8–10 mm, hirsute and strigose, eglandular or less commonly sparsely minutely stipitate-glandular. **Corollas** usually pink to purplish pink, less commonly violet, tubes 10–13 mm, limbs 8–11 mm in diam. **Nutlets** cylindric, 2.5–3.4 mm, not broadened at the base, black, commissure not reaching the apex, 1/3–1/2 as wide as the nutlet apex, apical appendage absent. 2n = 20 (Umber 1979).

Flowering Jun–Sep. Pine, pine-oak, pine-oak-birch, clearings, subalpine meadows, disturbed areas; 2200–2800(–3000) m; Ariz, N.Mex. Map in Fig. 8.

Glandularia chiricahensis is a distinct species recognized by its relatively tall, erect stems, short fruiting spikes, and eglandular calyces. The corollas commonly are relatively large and usually bright pink, similar to the characteristic corolla color in *G. pubera* (sometimes also seen in *G. gooddingii*. The flavonoid profiles of *G. chiricahensis* and *G. pubera* are essentially identical (Umber 1980) and they share a tetraploid chromosome number — perhaps evidence of close common ancestry and distinction as a pair apart from the hexaploids of the group (*G. bipinnatifida*, *G. wrightii*, *G. longidentata*, and probably *G. latilobata*).

Glandularia chiricahensis apparently is restricted to relatively high-elevation habitats in central to southeastern Arizona and adjacent New Mexico (Fig. 8). Additional collections examined (see type of *Verbena ambrosiifolia* forma *eglandulosa*, cited above) from New Mexico: **Grant Co.**: S end of the Black Range, Mimbres River, ca. 5500 ft, 20 Aug 1904, *Metcalfe 1231* (TEX); Redstone [ca. 20 km NNE of Silver City], 13 Aug 1895, *Mulford 896* (MO); mts. near Pinos Altos [ca. 11 km NNE of Silver City], 26 Jun 1936, *Stewart s.n.* (MO); just N of jct Hwy 90 and 61 at San Lorenzo, juniper zone, 14 Aug 1973, *Umber 625* (TEX). **Hidalgo Co.**: Peloncillo Mts, Clanton Canyon, ca. 2 mi below (east of) summit, Coronado Natl. Forest, 19 Aug 1952, *Tucker 2441* (LL); 9 mi NW of jct US 70 and US 90 on Hwy 90 Lordsburg, 15 Aug 1973, *Umber 631* (TEX).

GLANDULARIA PUBERA (Greene) Nesom, comb. nov. *Verbena pubera* Greene, Pittonia 5: 136. 1903. *Verbena ciliata* Benth. var. *pubera* (Greene) L.M. Perry, Ann. Missouri Bot. Gard. 20: 332. 1933. **TYPE: USA. Texas**. Jeff Davis Co.: Davis Mountains, 28 Apr 1902, *S.M. Tracy and F.S. Earle 337* (holotype: ND-G digital image!, Fig. 2 of the present report). *Tracy & Earle 162* has been cited or notated as the type, but the group of "162" duplicates constitutes a set of paratypes: **Texas**. Jeff Davis Co.: Davis Mts., 23 Apr 1902, *Tracy & Earle 162* (F digital image!, MO-2 sheets!, MO digital image!, ND-G digital image! Fig 2 of present report, NY digital image!, US digital image!). *Tracy & Earle 162a* (Fig. 3 of present report) also is a paratype.

Glandularia bipinnatifida (Nutt.) Nutt. var. *brevispicata* Umber, Syst. Bot. 4: 89. 1979. *Verbena bipinnatifida* Nutt. var. *brevispicata* (Umber) Moldenke, Phytologia 45: 470. 1980. **TYPE: USA. New Mexico**. Otero Co.: Mountain Park, yard of Trinity Baptist Church, corollas pink-purple, flowers with an acrid smell, [no date], *R. & J. Umber 607* (holotype: GH; isotypes: ARIZ, MO! MO-digital image!, NY-2 sheets-digital images!). This collection is the voucher for a chromosome count of *2n* = 30 (Umber 1979). At NY (00137539) and TEX (00375018 and 00375019) are specimens labeled by Umber as his collection 607 and annotated by him as "isotype," but they have slightly different label information from the protologue and from specimens with label data corresponding exactly to the protologue: "Abundant on the rocky, somewhat sandy hillsides in Mountain Park, New Mexico. This collection just NE of Trinity Baptist Church, not fragrant, viscid. Strong perennial." These variants should be regarded as paratypes.

Plants strongly perennial. **Stems** erect to ascending-erect, 15–40 cm, densely hirsute to pilose-hirsute or hirsutulous, at least some of the hairs prominently deflexed, eglandular. **Leaves** ovate to obovate in outline, membranaceous, blades 1–2 times longer than wide, 1–2(–3)-pinnatifid, ultimate segments oblong-lanceolate to lanceolate, midstem 4–5 cm, hirsutulous to strigose-hirsute, eglandular; petioles 3–7 mm. **Inflorescence** elongating to (2–)3–6 cm in fruit; floral bracts slightly shorter than the calyces. **Calyces** 8–10 mm, softly hirtellous, densely minutely stipitate-glandular. **Corollas** magenta to pink, tubes 12–15 mm, limbs 8–12 mm in diam. **Nutlets** subcylindric, 2.6–3.2 mm, slightly broadened at the base, black, commissure not reaching the apex, 1/2 as wide as the nutlet apex, apical appendage absent. $2n = 20$ (Turner & Powell 2005; Umber 1979, identified as *G. wrightii*; Lewis & Oliver 1961, identified as *G. wrightii*); $2n = 30$ (Umber 1979, identified as *G. bipinnatifida* var. *brevispicata*).

Flowering Feb–Aug. Rocky hillsides, rolling grassland, open oak woodland, pine-juniper, lava flows, road shoulders and embankments; (800–)1400–2300 m; Ariz., N.Mex., Tex.; Mexico (Chihuahua, Coahuila). Map in Fig. 9.

Glandularia pubera in the concept of the present study includes plants identified as *G. wrightii* by Umber (1979, p. 92), who noted that he was "applying the name *Glandularia wrightii* to those tetraploid populations [in trans-Pecos Texas] with an erect habit, compact spikes in flower and in fruit, a viscid inflorescence, and soft grayish leaves which form an acute angle with the stem." Turner and Powell's morphological concept of *G. wrightii* (2005) was essentially the same as Umber's but as observed here, that name has been incorrectly applied.

The description of *Glandularia bipinnatifida* var. *brevispicata* by Umber (1979) and his concept of it also are a close fit to the trans-Pecos Texas plants that he identified as *G. wrightii* (here = *G. pubera*). Umber observed (pp. 90–91) that var. *brevispicata* is "Easily recognized by its abbreviated congested spikes, short calyx teeth, viscid inflorescence, tall, erect or strongly ascending habit, and pink-purple flowers with tubes that are at least twice as long as the calyx." He also noted that "The fragrance of the flowers is not at all pleasant, unlike the usually sweet fragrance of the type variety [here = *G. wrightii*]… [but instead] reminiscent of an acrid chemical smell" — the fragrance is not diagnostic, however, as the holotype was observed to have a resinous smell while paratypes from very near the type locality were without any fragrance (as observed by Umber). Umber's key (p. 86) distinguished var. *brevispicata* by its corolla tubes 2–2.5 times longer than the calyx (vs. 1.5–2 times longer in *G. pubera*) and calyx lobes ca. 1 mm long (vs. 1.5–3.5 mm long in *G. pubera*), but these differences are not consistent.

Umber noted (1979, p. 91) that *Glandularia bipinnatifida* var. *brevispicata* is "primarily found in mountains and high plateaus of New Mexico, northeastern Arizona, and northern Mexico" (Coahuila and Nuevo León on his Figure 7 of 1979; his Fig. 3 of 1980). Remarkably, he mapped the populations of *G. wrightii* (here identified as *G. pubera*) as interposed directly between the New Mexico/Arizona populations and the Mexico populations of var. *brevispicata*. Umber's var. *brevispicata* and his *G. wrightii* are essentially identical in flavonoid profiles (Umber 1980), and the present study interprets all of these plants as representing a single evolutionary entity, identified here as *G. pubera* (Fig. 9).

Chromosome number of *Glandularia pubera*.

Turner (1998) included *Glandularia pubera* within his broad concept of *G. bipinnatifida* var. *ciliata*. Later, he and Powell (Turner & Powell 2005, p. 1660) recognized it as distinct, observing that in trans-Pecos Texas it "often grows in close proximity to *G. bipinnatifida* [here = *G. wrightii*] without showing signs of hybridization." Turner and Powell found that the two entities in that area also are distinct in ploidy level, with *G. pubera* consistently tetraploid ($2n = 20$, 4 populations

counted from 3 counties), while *G. wrtghtti* is consistently hexaploid (2*n* = 30, 18 populations counted from 7 counties) — confirmed here from vouchers at TEX.

The voucher for a tetraploid count, 2*n* = 20, from Apache Co., Arizona (Lewis & Oliver 1961) was identified by Umber as as *Glandularia bipinnatifida*. It seems likely that this was a plant of *G. pubera* in the present sense; I have not seen the voucher. The voucher for a tetraploid count, 2*n* = 20, from Apache Co., Arizona (ENE of Springerville on US 60, 4 Aug 2001, *Windham 2530*, MO!) is unequivocally a plant of *Glandularia pubera*.

Two inconsistencies are noted. (1) The voucher for a hexaploid count (Brewster Co., Texas, *Turner 24-159*, TEX; reported by Turner and Powell 2005) is a plant of typical *Glandularia pubera*. A duplicate of 24-159 at SRSC, however, is *G. wrightii* in the present sense (fide Mike Powell, pers. comm.) and more likely represents the species from which the chromosome sample originated. (2) Umber reported the chromosome number of the type collection of *G. bipinnatifida* var. *brevispicata* as hexaploid; this was the only count he reported from among the plants he identified as var. *brevispicata*. If Umber's count is correct and correctly vouchered, it documents the only record of a hexaploid within *G. pubera*, which otherwise apparently is composed of tetraploid populations.

Identification of *Glandularia gooddingii*.

Glandularia gooddingii in its typical form, with unlobed leaf margins, is easy to identify correctly. The combination of short floral bracts, densely stipitate-glandular calyces, short calyx lobes, and broad corolla limbs (10–14 mm in diam.) also is diagnostic. In Arizona, variants of *G. gooddingii* with deeply divided leaves and linear ultimate segments often are confused in identification with species of the *G. bipinnatifida* group — they are contrasted here. *Glandularia gooddingii* is currently documented unequivocally from New Mexico by only one collection from Hidalgo Co. (Nesom 2010).

1. Calyces eglandular or nearly so.

2. Calyces 5–7 mm; corolla tubes 7–11, limbs 6–9 mm in diam., purplish to blue or lavender ..... **Glandularia latilobata**
2. Calyces 8–10 mm; corolla tubes 10–13 mm, limbs 8–11 mm in diam., usually pink to purplish pink, less commonly violet ..... **Glandularia chiricahensis**

1. Calyces prominently stipitate-glandular.

3. Calyces (5–)6–7(–8) mm; corolla tubes 8–10 mm, limbs 10–14 mm in diam.; leaves commonly with 3 main divisions ..... **Glandularia gooddingii**
3. Calyces 8–10 mm; corolla tubes 12–15 mm, limbs 8–12 mm in diam.; leaves usually pinnatifid ..... **Glandularia pubera**

Glandularia gooddingii (Briq.) Solbrig, Madroño 15: 50. 1959. *Verbena gooddingii* Briq., Annuaire Conserv. Jard. Bot. Genève 10: 103. 1907. *Verbena bipinnatifida* var. *gooddingii* (Briq.) Jepson, Fl. Calif. 3: 382. 1943. **TYPE: USA. Nevada**. [Lincoln Co.]: Kernan, Meadow Valley Wash, sandy bottoms, 28 Apr 1902, *L.N. Goodding 645* (holotype: G-DEL; isotypes: F digital image!, GH, MO! digital image!, POM, RM, US digital image!).

Verbena gooddingii var. *nepetifolia* Tidestrom, Proc. Biol. Soc. Wash. 38: 15. 1925. **TYPE: USA. Nevada**. Lincoln Co.: El Dorado Cañon, near Colorado River, 600 m, 2 May 1919, *I. Tidestrom 8835* (holotype: US digital image!).

Plants perennial. **Stems** erect, basally ascending, 10–40 cm, pilose-hirsute, stipitate-glandular at least on the distal half, uncommonly eglandular. **Leaves** deltate to ovate or broadly ovate

in outline, membranaceous, blades 1.5–2 times longer than wide, incised to coarsely toothed with deltate to triangular teeth, ultimate segments deltate to ovate or lanceolate, to deeply divided with ultimate segments sublinear, midstem 2–5 cm, hirsute-strigose to strigose adaxially, hirsute abaxially, eglandular to very sparsely stipitate-glandular; petioles 3–10 mm. **Inflorescence** mostly remaining compact, elongating to 2–5(–8, –10) cm in fruit; floral bracts 1/2–3/4 as long as the calyces. **Calyces** (5–)6–7(–8) mm, densely minutely stipitate-glandular, pilose-hirsute, lobes 0.5–1 mm, shallowly deltate to triangular-deltate or triangular, usually apiculate. **Corollas** pink to purple or lavender, tubes 8–10 mm, limbs 10–14 mm in diam. **Nutlets** cylindric, 2.5–3(–3.5) mm, not broadened at the base, black, commissure not reaching the apex, 1/3–1/2 as wide as the nutlet apex, apical appendage absent. 2n = 30.

Flowering (Feb–)Mar–Jun (–Dec, sporadically). Talus, flats, hillsides, sandy ridges and bottoms, washes, river banks, streambeds, desert grassland, rocky slopes, roadsides, canyon bottoms, brittlebrush-tamarisk, oak, thornscrub, pinyon-juniper, ponderosa pine-juniper, oak-juniper-hackberry, oak chaparral, baccharis-mesquite-Chilopsis, oak-ash, *Larrea-Yucca-Fouquieria-Opuntia*, *Washingtonia*; 400–1500(–2000) m; Ariz., Calif., N.Mex., Nev., Utah; Mexico (Baja California, Sonora).

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Figure 1. Holotype of *Glandularia* (Verbena) *wrightii*, *Wright 1504*, GH.

Figure 2. Holotype of *Verbena pubera*, *Tracy & Earle 337*, ND-Greene — top two plants. Paratype of *Verbena pubera*, *Tracy & Earle 162* — bottom plant.

Figure 3. Paratype of *Glandularia* (Verbena) *pubera*, *Tracy & Earle 162a*, ND-Greene (see text).

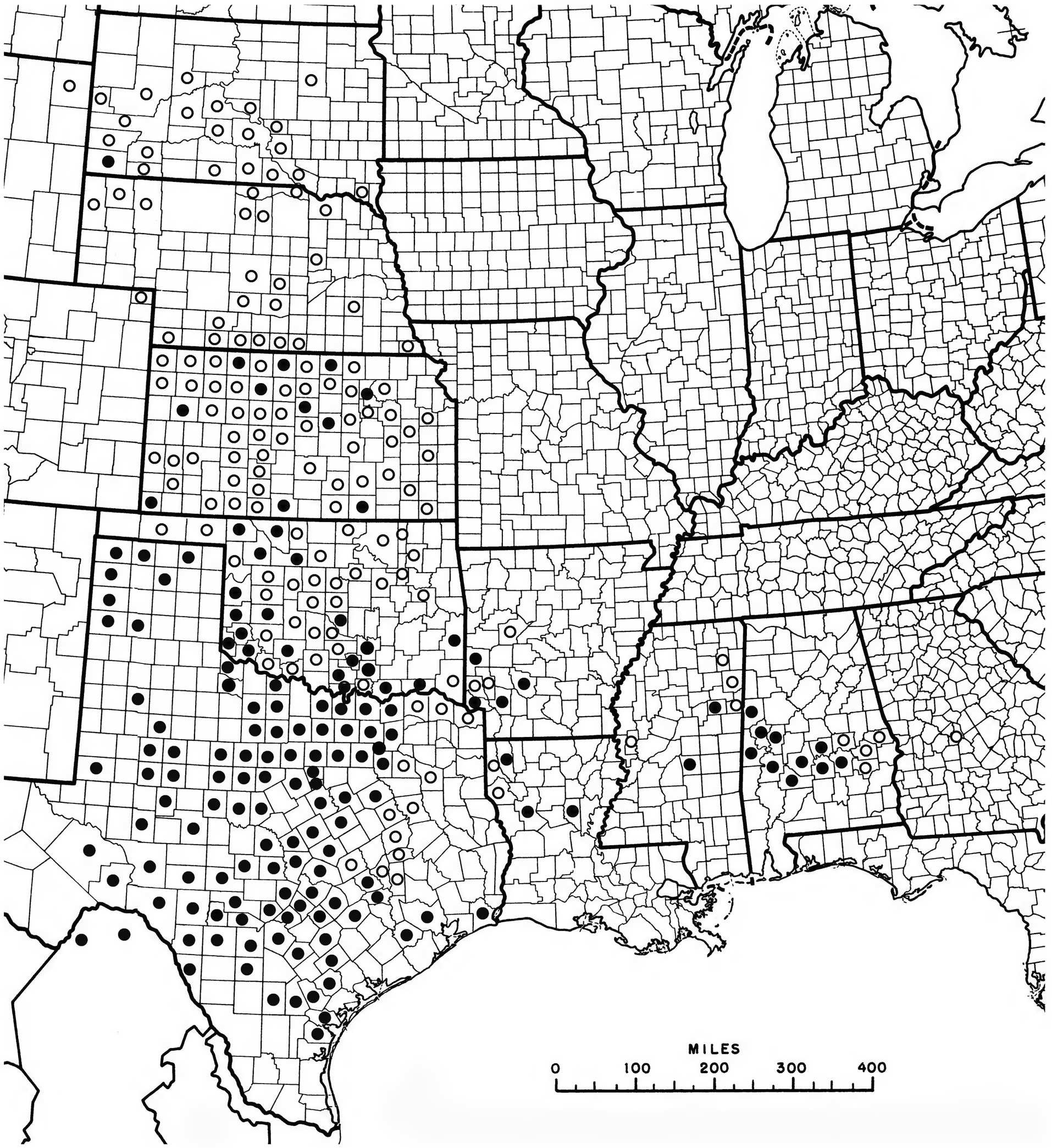

Figure 4. Distribution of *Glandularia bipinnatifida*. Open circles are records from literature, vouchers not seen.

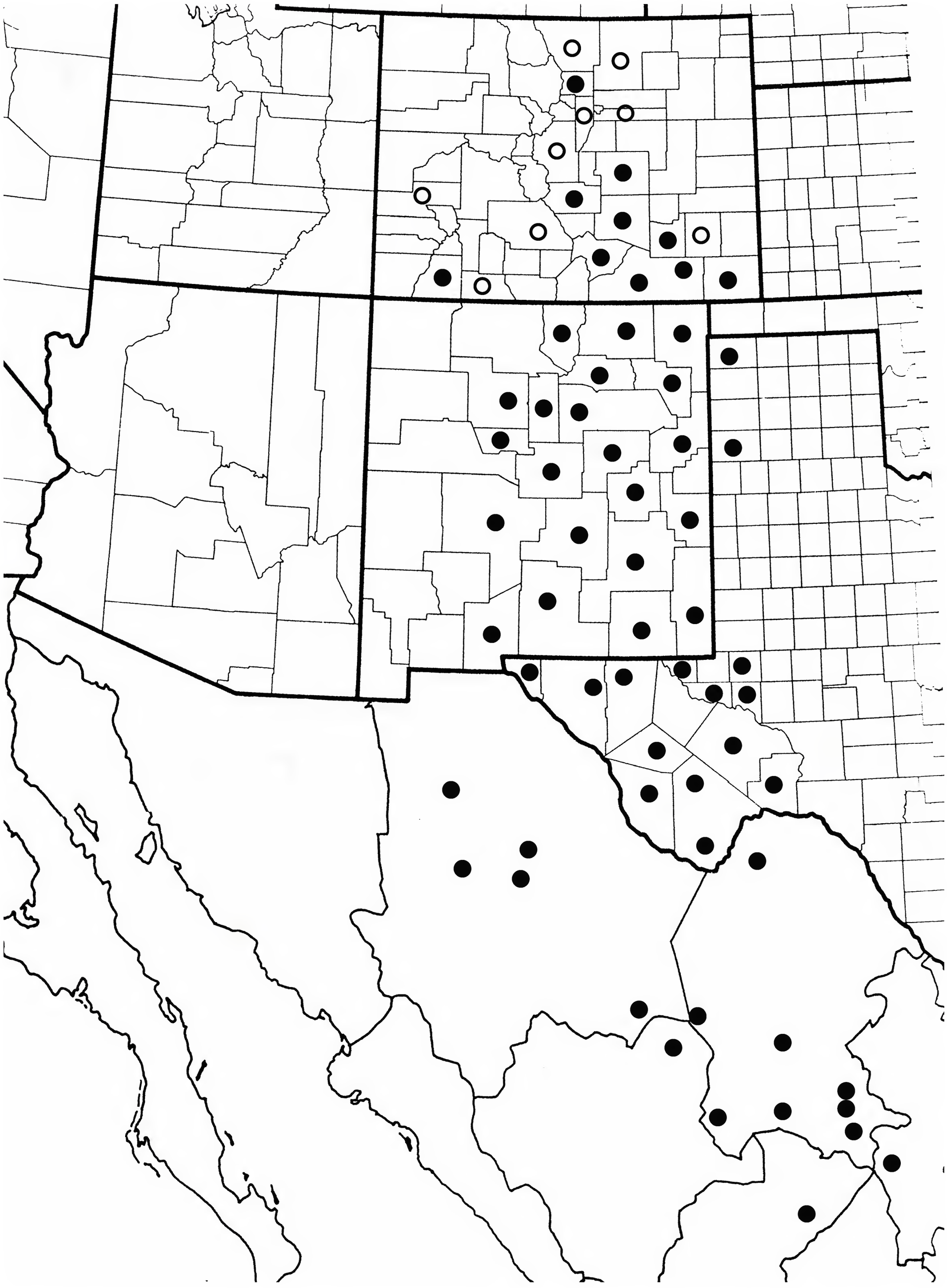

Figure 5. Distribution of *Glandularia wrightii*. Open circles are from the COLO Specimen Database (2010), vouchers not seen in the present study.

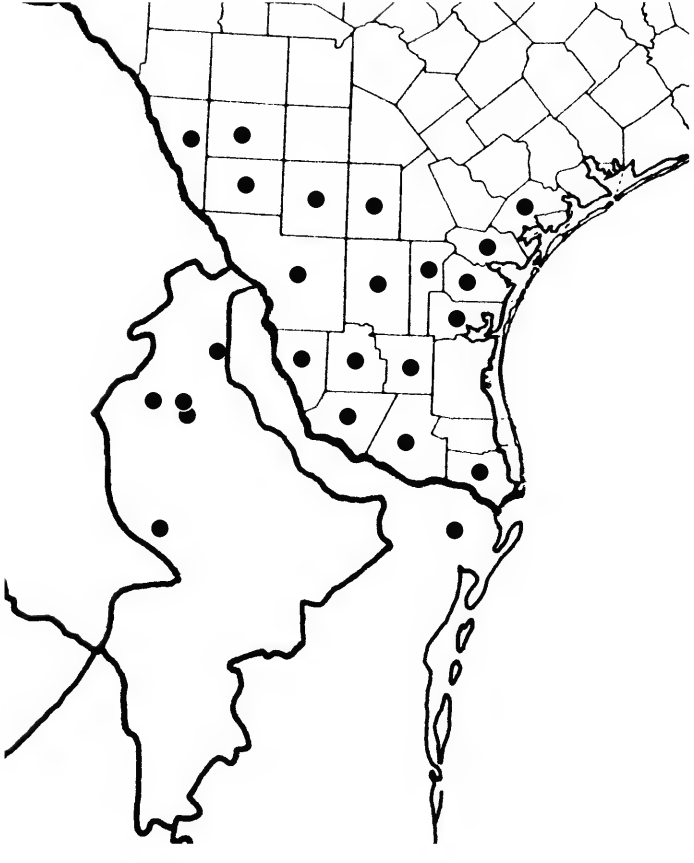

Figure 6. Distribution of *Glandularia longidentata*.

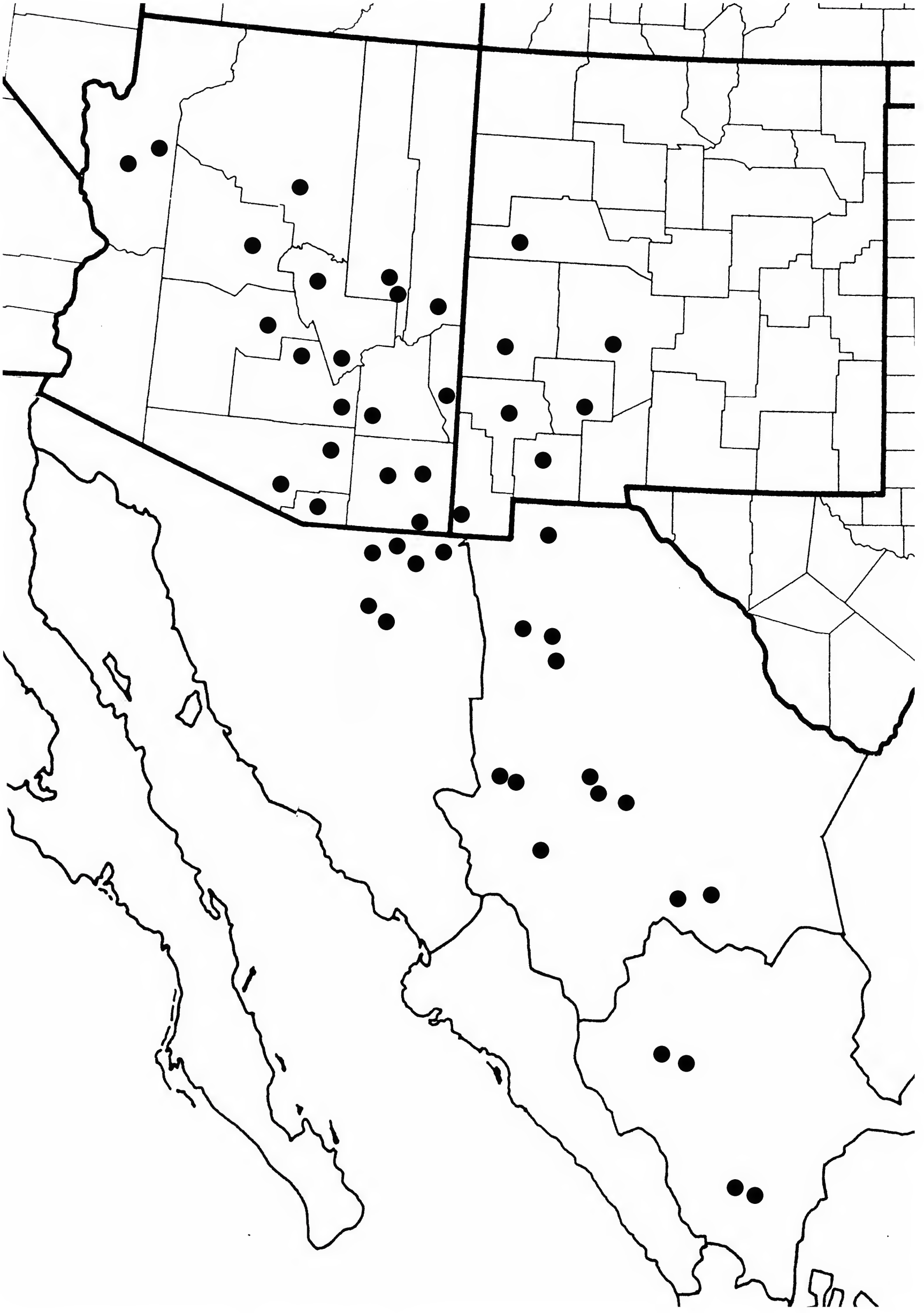

Figure 7. Distribution of *Glandularia latilobata*.

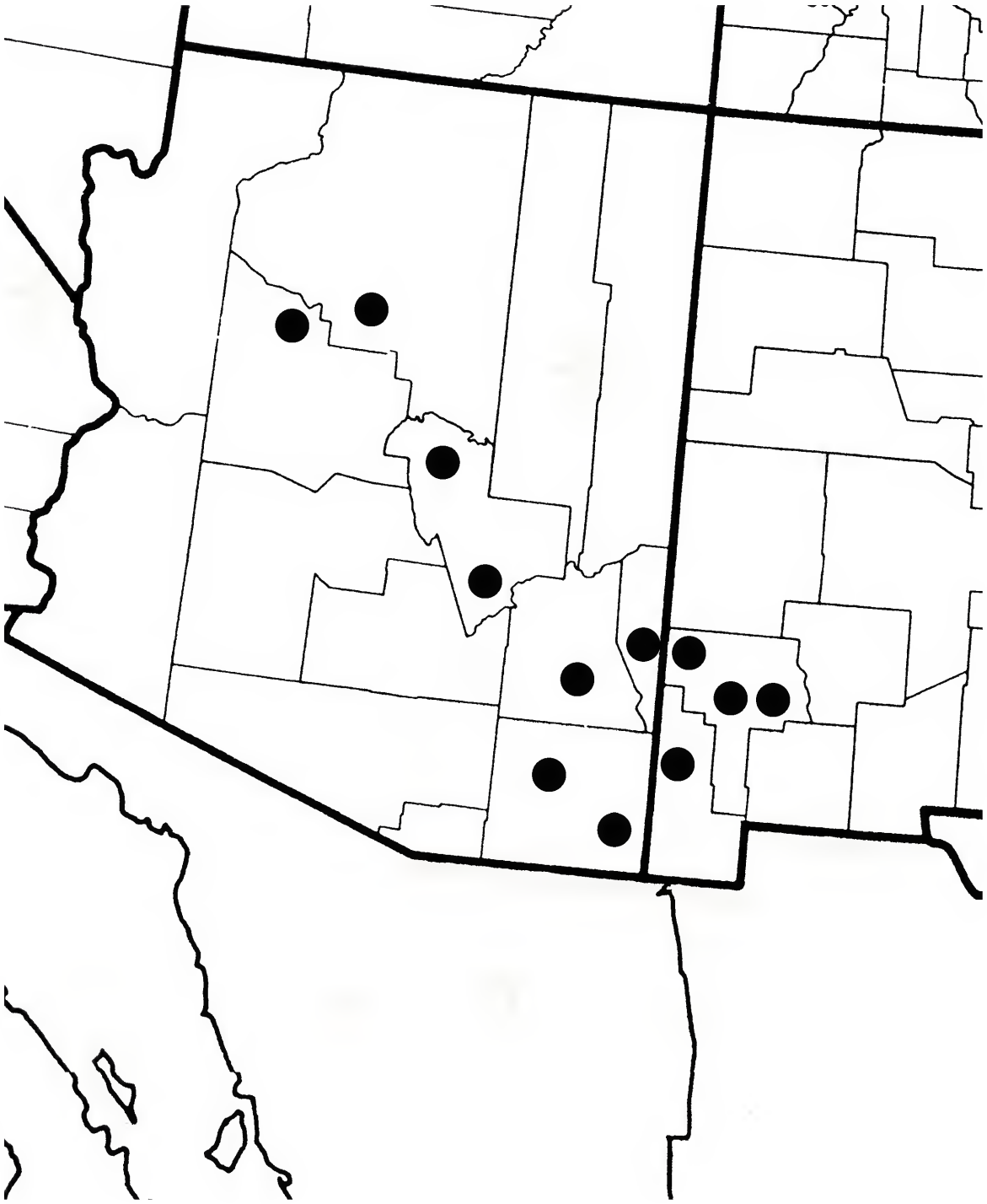

Figure 8. Distribution of *Glandularia chiricahensis*.

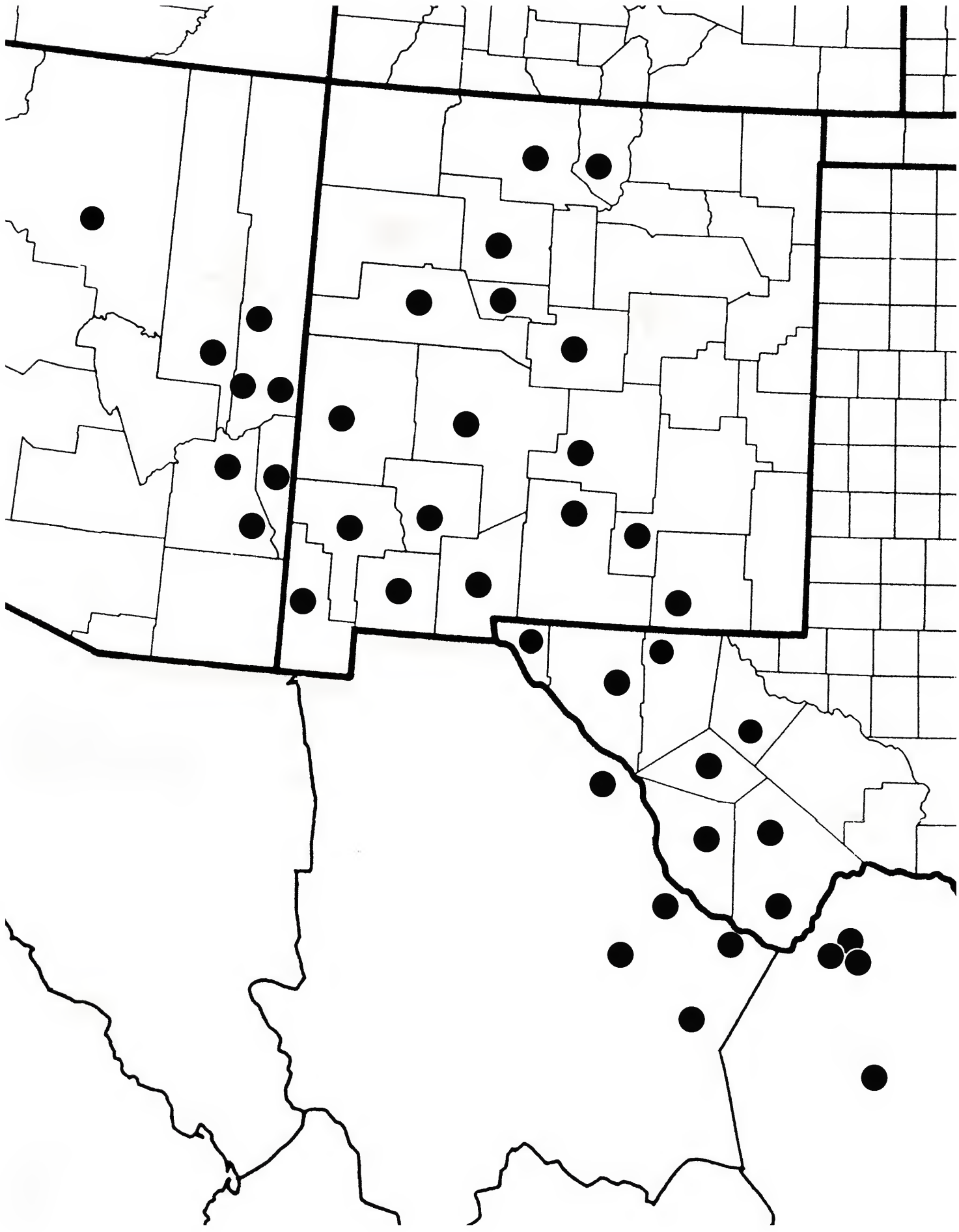

Figure 9. Distribution of *Glandularia pubera*.

Turner, B.L. 2010. *Hybanthus pennellii* (Violaceae) raised to specific rank: A gypsophile from Nuevo León, Mexico. Phytoneuron 2010-47: 1–2. Mailed 12 October 2010.

HYBANTHUS PENNELLII (VIOLACEAE) RAISED TO SPECIFIC RANK: A GYPSOPHILE FROM NUEVO LEÓN, MEXICO

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ABSTRACT

Hybanthus potosimus var. *pennellii* is elevated to specific rank as **Hybanthus pennellii** (C.V. Morton) B.L. Turner, comb. et stat. nov. It is a localized gypsophilic endemic of Nuevo León, most closely related to *H. potosimus* of San Luis Potosí, but amply distinct. Its relationship to the latter is briefly discussed and a map showing their distribution is provided.

KEY WORDS: *Hybanthus, H. pennellii, H. potosimus*, gypsophile, Nuevo León, Mexico

Routine identification of Mexican plants from Nuevo León has brought to focus the following gypsophile, previously identified as *Hybanthus potosimus* var. *pennellii* Morton, herein elevated to specific rank. Morton, in his original publication, gave only a brief description of his novelty, noting that it differed "from the typical variety in its acutish leaves, acuminate calyx lobes, and somewhat larger flowers, the labellum being 10 mm. long and 6 mm broad." Because of his limited description of var. *pennellii*, I provide the following more inclusive description, this based upon the two Hinton sheets cited below.

HYBANTHUS PENNELLII (C.V. Morton) B.L. Turner, **comb. et stat. nov.** Based upon *Hybanthus potosimus* C.V. Morton var. *pennellii* C.V. Morton, Contr. U.S. Natl. Herb. 29: 80. 1944. **TYPE: MEXICO. Nuevo León.** Mpio. Galeana, Alamar, Pab[l]illo, 2-3 Jul 1934, *F.W. Pennell 17231* (holotype: US digital image!).

Perennial herbs, 10–30 cm high. **Stems** simple, arising from slender rhizomes, beset with stiff spreading hairs ca 1 mm long. **Leaves** (at mid-stem) 3–5 cm long, 1.5–2.8 cm wide; petioles 1–3 mm long; blades elliptic to broadly obovate, appressed-pilose on both surfaces, mainly along the venation, margins weakly dentate to serrulate, the apices acute to obtuse. **Stipules** lanceolate, ca 3 mm long. **Flowers** axillary, the pedicels mostly 10–15 mm long. **Calyx** lobes lanceolate, ca 3 mm long, pubescent like the stems. **Petals** 5, the laterals purple, ca 3 mm long, their apices acute, reflexed; labellum ca 10 mm long, claw ca 4 mm long, the blades flabellate, ca 6 mm long, 7 mm wide, purplish-white, sparingly pubescent apically. **Capsules** ellipsoid, ca 5 mm long, 2.5 mm wide, glabrous; seeds 5–6, globose, glabrous, ca 1.5 mm across.

SPECIMENS EXAMINED. **MEXICO. Nuevo León.** Mpio. Galeana: La Poza to Rio de José, 1690 m, gypsum hillside, 25 Jul 1995, *Hinton et al. 25372* (TEX); E of Pablillo, 2108 m, gypsum hillside, 30 Oct 2009, *Hinton et al. 29053* (TEX).

The following key distinguishes the two taxa concerned:

1. Leaves (at mid-stem) 2.0–2.5 cm long; stipules ca 1.2 mm long; pedicels mostly ca 5 mm long; labellum ca 7 mm long; San Luis Potosí ..... **Hybanthus potosinus**
1. Leaves (at mid-stem) 3–5 cm long; stipules ca 3 mm long; pedicels mostly 10–15 mm long; labellum ca 10 mm long; Nuevo León ..... **Hybanthus pennellii**

Pennell (1886-1952) an expert on the family Scrophulariaceae, made his first collections in Mexico during the year 1934 (Camp 1952) obtaining *Hybanthus pennellii* from the vicinity of Pablillo, perhaps unaware of its gypseous substrate (this not recorded on his collection label) To my knowledge, there have been only two additional collections of the taxon, both by the Hintons and both from near the type locality Distribution of the two taxa is shown in Fig 1 The specific locality for the type of *H potosinus* was obtained from Sanchez (1969)

ACKNOWLEDGEMENTS

I am grateful to Guy Nesom for reviewing the paper A hi res photograph of an isotype (NY) of *Hybanthus potosinus* was obtained from the website JSTOR org an image of the holotype is on the US website

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Morton C V 1944 The genus *Hybanthus* in Continental North America Contr U S Natl Herb 29 74–82

Sanchez, M S 1969 Las colecciones botanicas de C A Purpus en Mexico Univ Calif Publ Bot 51 1–36

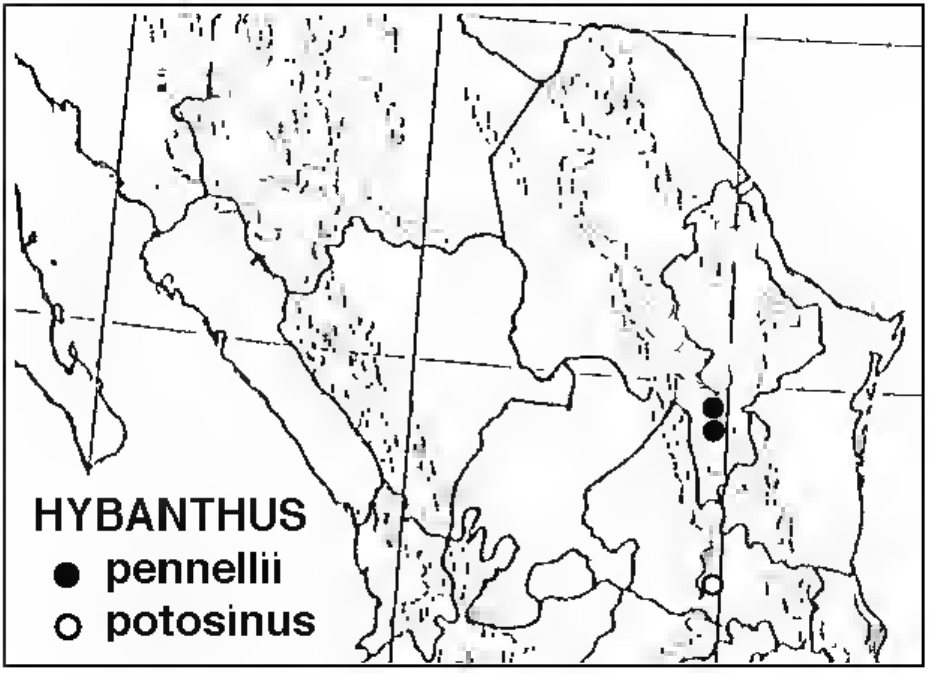

Figure 1 Distribution of *Hybanthus pennellii* and *H potosinus*

Wunderlin, R.P. 2010. Reorganization of the Cercideae (Fabaceae: Caesalpinioideae). Phytoneuron 2010-48: 1–5. Mailed 3 Nov 2010.

REORGANIZATION OF THE CERCIDEAE (FABACEAE: CAESALPINIOIDEAE)

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ABSTRACT

The tribe Cercideae is reorganized into 12 genera placed in two subtribes, Cercidinae (*Adenolobus*, *Cercis*, *Griffonia*) and Bauhiniinae (*Bauhinia*, *Barklya*, *Brenierea*, *Gigasiphon*, *Lysiphyllum*, *Phanera*, *Piliostigma*, *Schnella*, *Tylosema*). A key to the subtribes and genera is provided.

KEY WORDS: *Adenolobus*, *Barklya*, *Bauhinia*, *Brenierea*, *Cercis*, *Gigasiphon*, *Griffonia*, *Lysiphyllum*, *Phanera*, *Piliostigma*, *Schnella*, *Tylosema*

The Cercideae has been subject to much reorganization since its establishment by Bonn (1822). Recently, Wunderlin et al. (1987) recognized five genera in two subtribes: *Adenolobus* (Harvey ex Bentham & Hook. f.) Torre & Hillcoat, *Cercis* Linnaeus, and *Griffonia* Baillon in subtribe Cercidinae; *Bauhinia* Linnaeus and *Brenierea* Humbert in subtribe Bauhiniinae. Within the large genus *Bauhinia* (300–350 species), an infrageneric system was presented that recognized four subgenera, 22 sections, and 30 series.

Molecular studies in the Cercideae have revised our thinking about the classification of the tribe. Using ITS sequences of nuclear ribosomal DNA, Hao et al. (2003) concluded that extensive reorganization is warranted in the Cercideae if monophyletic groups are to be maintained. Based on molecular data, Lewis and Forest (2005) proposed that twelve genera should be recognized: *Adenolobus*, *Barklya* F. von Mueller, *Bauhinia*, *Brenierea*, *Cercis*, *Gigasiphon* Drake del Castillo, *Griffonia*, *Lasiobema* (Korthals) Miquel, *Lysiphyllum* (Bentham) de Wit, *Phanera* Loureiro, *Piliostigma* Hochstetter, and *Tylosema* (Schweinfurth) Torre & Hillcoat. Of these, seven (*Barklya*, *Gigasiphon*, *Lasiobema*, *Lysiphyllum*, *Phanera*, *Piliostigma*, and *Tylosema*) placed in synonymy of *Bauhinia* by Wunderlin et al. (1987) were reinstated by Lewis and Forest.

Studies by Sinou et al. (2009), who sequenced the plastid *trn*L-*trn*F region of 85 species of Cercideae, provide support for the recognition of most of the genera of Lewis and Forest (2005). *Adenolobus*, *Cercis*, and *Griffonia* appear in a distinct basal clade, while two major clades emerge with the other genera. One clade contains *Bauhinia* s. str., *Brenierea*, and *Piliostigma*, while the second contains *Barklya*, *Gigasiphon*, *Tylosema*, an "American *Phanera*", and a poorly resolved *Lasiobema*-*Lysiphyllum*-*Phanera* subclade. From these data and the author's personal knowledge of morphology in the tribe, the following reorganization consisting of 12 genera is proposed.

REORGANIZATION OF CERCIDEAE

Cercideae Bronn, De Formis Pl. Legum. 131. 1822. **TYPE**: *Cercis* L.

I. Subtribe **Cercidinae**

1. **Cercis** L., Sp. Pl. 374. 1753. **TYPE**: *Cercis siliquastrum* L. Lectotypified by Britton and Brown (Ill. Fl. N. U.S., ed. 2 2: 334. 1913). – 6 species; warm temperate northern hemisphere.
Siliquastrum Duhamel, Traité Arbr. Arbust. 2: 263. 1755. ≡ *Cercis* L.

2. **Adenolobus** (Harv. ex Benth. & Hook. f.) Torre & Hillc., in Exell & Mendonça, Bol. Soc. Brot., Ser. 2 29: 37. 1956. **TYPE**: *Adenolobus garipensis* (E. Mey.) Torre & Hillc. – 2 species; Africa.

3. **Griffonia** Baill., Adansonia 6: 188. 1865. **TYPE**: *Griffonia physocarpa* Baill. – 4 species; Africa.
Bandeiraea Welw. ex Benth. & Hook., Gen. Pl. 1: 577. 1865. **TYPE**: *Bandeiraea simplicifolia* (Vahl) Oliv. Lectotypified by Oliver (Fl. Trop. Africa 2: 285. 1871).

II. Subtribe **Bauhiniinae** (Benth.) Walp., Repert. Bot. Syst. 1: 847. 1842. **TYPE**: *Bauhinia* L.

4. **Bauhinia** L., Sp. Pl. 374. 1753. **TYPE**: *Bauhinia divaricata* L. – 150–160 species; North America, Mexico, Central America, West Indies, South America, Africa, Asia, Malesia.
Pauletia Cav., Icon. 5: 5. 1799. **TYPE**: *Pauletia inermis* Cav. Lectotypified by de Wit (Reinwardtia 3: 391. 1956).
Amaria S. Mutis ex Caldas, Semanario Nueva Granada 2: 25. 1810. **TYPE**: *Amaria petiolata* S. Mutis ex DC. Lectotyified by Britton and Killip (Ann. New York Acad. Sci. 35: 164. 1936).
Casparia Kunth, Ann. Sci. Nat. (Paris) 1: 85. 1824. **TYPE**: *Casparia pes-caprae* (Cav.) Kunth. Lectotypified by Britton and Rose (N. Amer. Fl. 23: 208. 1930).
Perlebia Mart., in Martius & Spix, Reise Bras. 2: 555. 1828. **TYPE**: *Perlebia bauhinioides* Mart.
Cansenia Raf., Sylva Tellur. 122. 1838. **TYPE**: *Cansenia ungulata* (L.) Raf. Lectotypified by Wunderlin (Rhodora 78: 753. 1976).
Mandarus Raf., Sylva Tellur. 122. 1838. ≡ *Bauhinia* L.
Monoteles Raf., Sylva Tellur. 122. 1838. **TYPE**: *Monoteles paradoxa* Raf.
Telestria Raf., Sylva Tellur. 122. 1838. **TYPE**: *Telestria purpurea* (L.) Raf. Lectotypified by Wunderlin (Rhodora 78: 757. 1976).
Alvesia Welw., Ann. Cons. Ultamar. (Portugal), Parte Não Off., Ser. 1 ("Apont.") 1858: 587, nom. rej. vs. *Alvesia* Welw. 1869 (Lamiaceae). **TYPE**: *Alvesia bauhinioides* Welw.
Ariaria Cuervo, Prehist. Viajes 219. 1893. **TYPE**: *Ariaria superba* Cuervo.
Caspareopsis Britton & Rose, N. Amer. Fl. 23: 217. 1930. **TYPE**: *Caspareopsis monandra* (Kurz) Britton & Rose.

5. **Barklya** F. Muell., J. Proc. Linn. Soc., Bot. 3: 158. 1859. **TYPE**: *Barklya syringifolia* F. Muell. – 1 species; Australia.

6. **Brenierea** Humbert, Compt. Rend. Hebd. Séances Acad. Sci. 249: 1599. 1959. **TYPE**: *Brenieraea insignis* Humbert – 1 species; Madagascar.

7. **Gigasiphon** Drake, in Grandidier, Hist. Phys. Madagascar 30(1): 88. 1902. **TYPE**: *Gigasiphon humblotianum* (Baill.) Drake – 5 species; Africa, Malesia.
Tournaya A. Schmitz, Bull. Jard. Bot. Natl. Belg. 43: 397. 1973. **TYPE**: *Tournaya gossweileri* (Bakh. f.) A. Schmitz.

8. **Lysiphyllum** (Benth.) de Wit, Reinwardtia 3: 431. 1956. **TYPE**: *Lysiphyllum cunningamii* (Benth.) de Wit. Lectotypified by de Wit (Reinwardtia 3: 431. 1956) – 9 species; Africa, Asia, Malesia, Australia.

Bracteolanthus de Wit, Reinwardtia 3: 415. 1956. **TYPE**: *Bracteolanthus dipterus* (Blume ex Miq.) de Wit.

9. **Phanera** Lour., Fl. Cochinch. 37. 1790. **TYPE**: *Phanera coccinea* Lour. – Ca. 90-100 species; Asia, Malesia.

Lasiobema (Korth.) Miq., Fl. Ned. Ind. 1(1): 71. 1855. **TYPE**: *Lasiobema scandens* (L.) de Wit. Lectotypified by de Wit (Reinwartia 3: 422. 1956).

10. **Piliostigma** Hochst., Flora 29: 598. 1846, nom. cons. **TYPE**: *Piliostigma reticulatum* (A. DC.) Hochst., type cons. – 5 species; South America, Africa, Asia, Malasia, Australia.

Elayuna Raf. Sylva Tellur. 145. 1838, nom. rej. vs. *Piliostigma* Hochst. **TYPE**: *Elayuna biloba* Raf.

Locellaria Welw., Ann. Cons. Ultamar. (Portugal), Parte Não Off., Ser. 1 ("Apont.") 1858: 588. **TYPE**: *Locellaria bauhinioides* Welw.

11. **Schnella** Raddi, Quar. Piant. Nuov. Bras. 32. 1820. **TYPE**: *Schnella macrostachya* Raddi. Lectotypified by Britton and Rose (N. Amer. Fl. 23: 205. 1930). – Ca. 40 species; Mexico, Central America, South America.

Lacara Spreng., Neue Entdeck. Pflanzenk. 3: 56. 1822. **TYPE**: *Lacara triplinervia* Spreng.

Caulotretus Rich. ex Schott, in Sprengel, Syst. Veg. 4(2): 406. 1827. **TYPE**: *Caulotretus smilacinus* Schott.

12. **Tylosema** (Schweinf.) Torre & Hillc., in Exell & Mendonça, Bol. Soc. Brot., ser. 2. 29: 38. 1955. **TYPE**: *Tylosema fassoglensis* (Kotschy ex Schweinf.) Torre & Hillc. – 4 species; Africa.

KEY TO THE SUBTRIBES AND GENERA OF THE CERCIDEAE

1. Seeds with a circular hilum; funicular aril lobes absent (**I. Subtribe Cercidinae**).

    2. Fruits with a dorsal wing; corolla pseudopapilionaceous; temperate northern hemisphere ..... ***Cercis***
    2. Fruits lacking a dorsal wing; corolla only slightly zygomorphic; Africa.

        3. Gynophore free from the abaxial wall of the hypanthium; fruit with the gynophore and persistent style appearing confluent with the dorsal margin (semilunate), valves thin; shrubs or small trees ..... ***Adenolobus***
        3. Gynophore connate with the abaxial wall of the hypanthium; fruit with the gynophore and persistent style obliquely attached, valves thick; scandent shrubs or lianas ..... ***Griffonia***

1. Seeds with a crescentic hilum; funicular aril lobes present (**II. Subtribe Bauhiniinae**).

    4. Branches modified into cladodes; petals absent ..... ***Brenierea***
    4. Branches not modified into cladodes; petals (1–)5(–6).

        5. Trees or shrubs (rarely semiscandent), sometimes with intrastipular spines, rarely with thorns, never with tendrils.

            6. Calyx spathaceous or dividing to the hypanthium into 2–5 lobes.

7. Leaves entire, the midrib stout and with strong lateral veins; sepals with an apical nectary ..... ***Gigasiphon***
7. Leaves entire, bilobed, or entire (if entire, the midrib lacking strong lateral veins); sepals lacking an apical nectary ..... ***Bauhinia***

6. Calyx only lobed in the upper part.

8. Calyx closed and irregularly splitting at anthesis ..... ***Piliostigma***
8. Calyx open before anthesis ..... ***Barklya***

5. Lianas, or vines (rarely shrubs) with tendrils (rarely without), never with intrastipular spines or thorns.

9. Fertile stamens 10.

10. Calyx regularly split in the upper part or to the mouth of the hypanthium into 2–5 lobes; Africa, Asia, Malesia, and Australia ..... ***Lysiphyllum***
10. Calyx irregularly 2- to 5-lobed or dentate in the upper part; tropical North and South America ..... ***Schnella***

9. Fertile stamens 2–3.

11. Fertile stamens 2; upper petal smaller and bicallose at the base ..... ***Tylosema***
11. Fertile stamens 3; upper petal larger, not bicallose at the base ..... ***Phanera***

DISCUSSION

A diagram of subtribal and generic relationships in the Cercideae presented here (Fig. 1) includes two subtribes and 12 genera. It incorporates molecular (Forest unpublished, cf. Lewis & Forest 2005; Sinou et al. 2009;) and morphological data from a variety of sources, including recent monographs, revisions, floras, and the author's personal study of the tribe during the last 30 years. This system is similar to that of Lewis and Forest (2005) except that *Schnella* is recognized as a genus distinct from *Phanera* and the genus *Lasiobema*, recognized by Lewis and Forest (2005), is placed in synonymy in *Phanera*.

Figure 1 shows subtribe Cercidinae with the warm temperate genus *Cercis* as basal and a clade containing the African genera *Griffonia* and *Adenolobus* as sister to *Cercis*. The placement of these three small distinctive genera, as proposed by Wunderlin (1987), remains unchanged.

Bauhiniinae has two major clades containing the remaining nine genera. The first has the large pantropical *Bauhinia* (150–160 species), and the two small genera *Brenierea* (1 species; Madagascar) and *Piliostigma* (5 species; 3 in the tropical Old World, 2 in South America). With the exception of the very distinctive *Brenierea*, all were previously recognized by Wunderlin (1987) as sections of *Bauhinia*. The second clade contains the three small genera, *Barklya* (1 species; Australia), *Gigasiphon* (5 species; Africa, Malesia), and *Tylosema* (4 species; Africa) and three closely related genera, *Lysiphyllum* (9 species; Old World tropics), *Phanera* (90–100 species; Asia, Malesia), and *Schnella* (ca. 40 species; tropical America). All of these were previously recognized by Wunderlin (1987) within *Bauhinia*. *Lasiobema*, recognized at the generic level by Lewis and Forest (2005) who alluded to the fact that it is not well supported by molecular data, is here included with *Phanera*. Morphological data also does not support its segregation from *Phanera*. *Lysiphyllum* is sister to *Phanera* (Fig. 1) and is readily distinguished from that genus by having 10 fertile stamens

(*Phanera* having 2–3 fertile stamens) (see key). Preliminary molecular data (Forest unpubl., cf Lewis & Forest 2005, Sinou 2009) show *Schnella* as distinct from *Phanera*. This is supported by morphological data and *Schnella* is accordingly elevated to the genus level here. The neotropical genus *Schnella* is very distinctive from the paleotropical genus *Phanera* and can easily be distinguished by its species having 10 fertile stamens (vs. 2–3 fertile stamens in *Phanera*).

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Sinou, C., Forest, F., Lewis, G.P., & Bruneau, A. 2009. The genus *Bauhinia* s.l. (Leguminosae): a phylogeny based on the plastid *trn*L-*trn*F region. Botany 87: 947–960.

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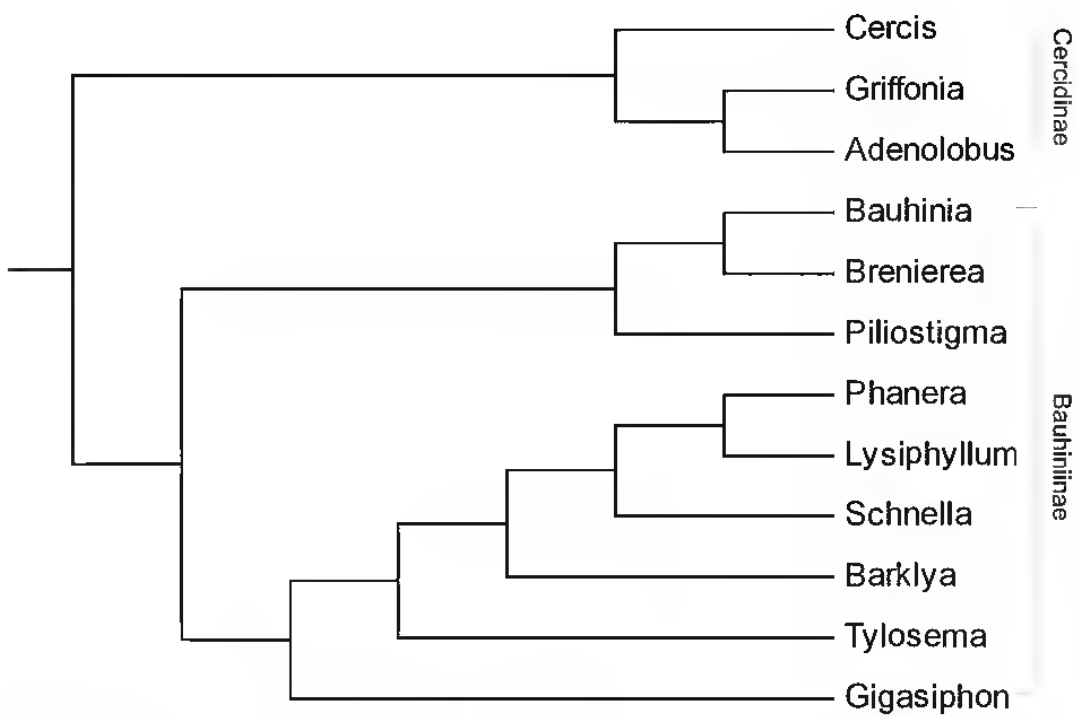

Figure 1. Diagram of relationships in the tribe Cercideae.

Wunderlin, R.P. 2010. New combinations in *Schnella* (Fabaceae: Caesalpiniodeae: Cercideae). Phytoneuron 2010-49: 1–5. Mailed 3 Nov 2010.

NEW COMBINATIONS IN *SCHNELLA* (FABACEAE: CAESALPINIODEAE: CERCIDEAE)

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ABSTRACT

New combinations are proposed for 28 species and one section in *Schnella*. The taxa are segregated from the genera *Bauhinia* and *Phanera*.
KEY WORDS: *Schnella*, Cercideae, Fabaceae.

Giuseppe Raddi (1770–1829) described the genus *Schnella* (p. 32) (Fabaceae: Caesalpiniaceae: Cercideae) and two species *S. macrostachya* (p. 32–33, fig. 4) and *S. microstachya* (p. 33) in *Quaranta Piante Nuove del Brasile* (1820) a preprint from *Mem. Mat. Fis. Soc. Ital. Modena* 18(2): 382–414. 1821 (see Stafleu and Cowan 1983: 538). Although Stafleu and Cowan cited "1820" for pages 382–414, they gave "Jan 1821" for pages 313–349. There is no evidence that the relevant pages were published out of sequence, so 1821 should be accepted as the date of publication as did Goldenberg and Baldini (2002).

Early workers (e.g., Don 1832; Grisebach 1860) followed Raddi and described new species in *Schnella*. Bentham (1840, 1844, 1845) at first similarly recognized *Schnella* as a genus but later (1865) reduced it to a section of *Bauhinia*. Sixty five years later Britton and Rose (1930) reinstated it as a genus, recognizing nine species, two of them new, followed by Britton and Killip (1936), who recognized 10 species in Colombia, four of them new. This was at first followed by a few others, but most later workers placed species previously recognized in *Schnella* in the expanded genus *Bauhinia*. Schmitz (1973) again briefly recognized *Schnella* on the basis of his pollen studies. In their reorganization of the Cercideae, Wunderlin et al. (1987) followed Bentham (1865) in recognizing it as a section of *Bauhinia*, along with 10 other sections in the subgenus *Phanera*, one of four subgenera in *Bauhinia* sensu lato. Lewis and Forest (2005), using molecular studies by Forest (unpublished), recognized 12 genera in the Cercideae and placed the tropical American species of tendriled lianas (*Schnella* sensu Raddi and others) in the Old World genus *Phanera*, but they indicated that *Schnella* may prove to be distinct. Molecular studies of Sinou et al. (2009) supported the work of Lewis and Forest (2005).

Following the concept proposed by Lewis and Forest (2005), Queiroz (2006) described a new species and made three new combinations in *Phanera* species from the Brazilian Caatinga. Subsequently Vaz (2010) made 29 new combinations by transferring more Brazilian species into *Phanera*.

Schnella can easily be distinguished from *Phanera* by a variety of characters, most evidently by the presence of 10 fertile stamens in the former as contrasted by 3(–2) in the latter. *Schnella* as recognized here consists of about 40 species. It is divided into two sections that are distinguished in the following key.

1. Calyx 5-nerved, the nerves often inconspicuous; ovary 1(–2) ovulate; fruit always thin-valved, indehiscent ..... I. Section *Schnella*
1. Calyx conspicuously 10- or 15-nerved; ovary 3- to 6-ovulate; fruit woody, dehiscent (thin-valved and indehiscent in *S. herrerae*) ..... II. Section *Caulotretus*

Wunderlin and Eilers (2009) revised the species placed here in section *Schnella* and Vaz (1979) treated the Brazilian species in section *Caulotretus*.

Schnella Raddi, Quar. Piant. Nuov. Bras. 32. 1820. *Bauhinia* sect. *Schnella* (Raddi) Benth., in Bentham & Hooker. f., Gen. Pl. 1: 576. 1865. **TYPE**: *Schnella macrostachya* Raddi. Lectotype designated by Britton and Rose (N. Amer. Fl. 23: 205. 1930).

Lacara Sprengel Neue Entdeck. Pflanzenk. 3: 56. 1822. **TYPE**: *Lacara triplinervia* Spreng. [?=*Schnella smilacina* (Schott) G. Don].

Caulotretus Rich. ex Schott, in Sprengel, Syst. Veg. 4(2): 406. 1827. **TYPE**: *Caulotretus smilacina* Schott [=*Schnella smilacina* (Schott) G. Don].

Caulotretus sect. *Eucaulotretus* Endl., Gen. Pl. 1317. 1840, nom. inval.

I. **Schnella** sect. **Schnella**

Schnella lilacina (Wunderlin & Eilers) Wunderlin, comb. nov. Basionym: *Bauhinia lilacina* Wunderlin & Eilers, J. Bot. Res. Inst. Texas 3: 621. 2009. **TYPE**: **Brazil**. Bahia: Km 5 on Núcleo Colonial de Una-São José Highway (BR101), 4 Aug 1977 *Silva Mattos & Hage 81* (holotype CEPEC!; isotypes: K!, US!)

Schnella maximiliani (Benth.) Wunderlin, comb. nov. Basionym: *Bauhinia maximiliani* Benth., in Martius, Fl. Bras. 15(2): 207. 1870. **TYPE**: **Brazil**. Espírito Santo: Vila de Nova Almeida, s.d., *Wied-Neuwied s.n.* (holotype: BR; isotype: M; photo ex RB!).

Schnella poiteauana (Vogel) Wunderlin, comb. nov. Basionym *Bauhinia poiteauana* Vogel, Linnaea 13: 309. 1839. **TYPE**: **French Guiana**. 1844, *Poiteau s.n.* (holotype: B, destroyed; lectotype: K!, photo ex B: US!; photo ex K: US!). Lectotype designated by Wunderlin and Eilers (J. Bot. Res. Inst. Texas 3: 625. 2009).

Schnella trichosepala (L.P. Quieroz) Wunderlin, comb. nov. Basionym: *Phanera trichosepala* L.P. Quieroz, Neodiversity 1: 7. 2006. **TYPE**: **Brazil**. Bahia: Ruy Barbosa, Serra do Orobó, trilha para o Pátio das Orquídeas, 12°18'S 40°29'W, 8 Feb 2005, *Cardoso 281* (holotype: UUEFS; isotypes: CEPEC, K).

II. **Schnella** sect. **Caulotretus** (DC.) Wunderlin, comb. nov. *Bauhinia* sect. *Caulotretus* DC., Prodr. 2: 516. 1825. **TYPE**: *Bauhinia glabra* Jacq. [=*Schnella glabra* (Jacq.) Dugand. Lectotype designated by Wunderlin et al. (Biol. Skr. 28: 25. 1987.).

Binaria Raf., Sylva Tellur. 122. 1838. *Bauhinia* subsect. *Binaria* (Raf.) Wunderlin et al., Biol. Skr. 28: 25. 1987. **TYPE**: *Binaria cumanensis* (Kunth) Raf. [=*Schnella glabra* (Jacq.) Dugand].

Bauhinia sect. *Tylotaea* Vogel, Linnaea 13: 312. 1839. *Caulotreus* sect. *Tylotaea* (Vogel) Endl., Gen. Pl. 1317. 1840. **TYPE**: *Bauhinia kunthiana* Vogel [=*Schnella kunthiana* (Vogel) Wunderlin. Lectotype designated by Wunderlin et al. (Biol. Skr. 28: 25. 1987).

Cardenasia Rusby, Mem. New York Bot. Gard. 7: 257. 1927. **TYPE**: *Cardenasia setacea* Rusby [=*Schnella glabra* (Jacq.) Dugand].

Bauhinia sect. *Caulotretus* subsect. *Latisiliquae* Wunderlin et al., Biol. Skr. 28: 25. 1987. **TYPE**: *Bauhinia herrerae* (Britton & Rose) Standl. & Steyerm. [=*Schnella herrerae* Britton & Rose).

Schnella alata (Ducke) Wunderlin, comb. nov. Basionym: *Bauhinia alata* Ducke, Arch. Jard. Bot. Rio de Janeiro 4: 55. 1925. **TYPE**: **Brazil**. Pará: Rio Tapajós, Vila Braga, 24 May 1923, *Ducke s.n.* (lectotype: RB; isolectotype: P). Lectotype designated by Vaz (Rodriguésia 61(Sup): S33–S40. 2010).

Schnella altiscandens (Ducke) Wunderlin, comb. nov. Basionym: *Bauhinia altiscandens* Ducke, Bol. Técn. Inst. Agron. N. 2: 17. 1944. **TYPE**: **Brazil**. Amazonas: Esperança, mouth of the Rio Javari, 28 Jan 1942, *Ducke 895* (holotype: RB; isotype: MG, SI).

Schnella anamesa (J.F. Macbr.) Wunderlin, comb. nov. Basionym: *Bauhinia anamesa* J.F. Macbr., Contr. Gray Herb. 59: 22. 1919. **TYPE**: **Brazil**. Goiás: near Goiás, s.d., *Burchell 7337* (holotype: K).

Schnella angulosa (Vogel) Wunderlin, comb. nov. Basionym: *Bauhinia angulosa* Vogel, Linnaea 13: 312. 1839. **TYPE**: **Brazil**. s.d., *Sellow 980* (holotype: B, destroyed; isotype: K!; photo ex B: F!, US!, photo ex K: NY!, RB, US!).

Schnella carvalhoi (Vaz) Wunderlin, comb. nov. Basionym: *Bauhinia carvalhoi* Vaz, Brittonia 47: 376. 1995. **TYPE**: **Brazil**. Bahia: Uruçuca, Distrito de Serra Grande, 7.3 km on Serra Grande/Itacaré road, Fazenda Lagoa do Conjunto Santa Cruz, 7 Sep 1991, *Carvalho et al. 3610* (holotype: CEPEC; isotypes NY!, RB).

Schnella confertiflora (Benth.) Wunderlin, comb. nov. Basionym: *Bauhinia confertiflora* Benth., in Martius, Fl. Bras. 15(2): 206. 1870. **TYPE**: **Brazil**. Amazonas: Rio Negro, "sylvis Yapurensibus", s.d., *Martius 2974* (holotype: M; photo ex M: F!, G!, US!).

Schnella cupreonitens (Ducke) Wunderlin, comb. nov. Basionym: *Bauhinia cupreonitens* Ducke, Arch. Jard. Bot. Rio de Janeiro 4: 56: 1925. **TYPE**: **Brazil**. Pará: Rio Majú, lower Rio Amazonas, 3 Nov 1923, *Ducke 16973* (holotype: RB; isotypes: B, destroyed, IAN, K!, US!; photo ex B: F!, US!).

Schnella erythrantha (Ducke) Wunderlin, comb. nov. Basionym: *Bauhinia erythrantha* Ducke, Arg. Inst. Biol. Veg. 4: 14. 1938. **TYPE**: **Brazil**. Amazonas: near Borba, Rio Madeira, 27 Apr 1937, *Ducke 35434* (holotype: RB; isotypes: G!, K!, IAN, P!).

Schnella grazielae (Vaz) Wunderlin, comb. nov. Basionym: *Bauhinia grazielae* Vaz, Atas Soc. Bot. Brasil, Secç. Rio de Janeiro 2(9): 73. 1984. **TYPE**: **Brazil**. Espírito Santo: Mata de Dourados, 6 Nov 1953, *Duarte & Gomes 3683* (holotype: RB; isotypes: CVRD, K).

Schnella guianensis (Aubl.) Wunderlin, comb. nov. Basionym: *Bauhinia guianensis* Aubl., Hist. Pl. Guiane 1: 377. 1775. **TYPE**: **French Guiana**. Cayenne, 1775, *Aublet s.n.* (holotype: P; isotypes: BM!, fragment F!; photo ex BM: US!).

Schnella klugii (Standl.) Wunderlin, comb. nov. Basionym: *Bauhinia klugii* Standl., Publ. Field Mus. Bot. Nat. Hist., Bot. Ser. 22: 143. 1940. **TYPE**: **Peru**. San Martín: Chazuta, Río Huallaga, Mar 1935, *Klug 4027* (holotype: F!; isotype NY!, US!).

Schnella kunthiana (Vogel) Wunderlin, comb. nov. Basionym: *Bauhinia kunthiana* Vogel, Linnaea 13: 312. 1839. **TYPE**: **French Guiana**. Dec 1824, *Potteau s.n.* (holotype: B, destroyed; photo ex B: F!, US!).

Schnella longiseta (Fróes) Wunderlin, comb.nov. Basionym: *Bauhinia longiseta* Fróes, Bol. Técn. Inst. Agron. N. 19: 25. 1951. **TYPE**: **Brazil**. Amazonas: São Paulo de Olivença, Rio Solimões, 10 Dec 1948, *Fróes 23699* (holotype: IAN; isotype: NY!, RB, US!).

Schnella outimouta (Aubl.) Wunderlin, comb. nov. Basionym: *Bauhinia outimouta* Aubl., Hist. Pl. Guiane 1: 375. 1775. **TYPE**: **French Guiana**. s.d., *Aublet s.n.* (Lectotype: W; photo ex W: F!, MO!, US!; isotype: BM!; photo ex BM: NY!). Lectotype designated here.

Schnella platycalyx (Benth.) Wunderlin, comb. nov. Basionym: *Bauhinia platycalyx* Benth., in Martius, Fl. Bras. 15(2) 207. 1870. **TYPE**: **Brazil**. Pará: Caripi, s.d. *Spruce 250* (holotype: K).

Schnella porphyrotricha (Harms) Wunderlin, comb. nov. Basionym: *Bauhinia porphyrotricha* Harms, Notizbl. Königl. Bot. Gart. Berlin 6: 307. 1915. **TYPE**: **Brazil**. Acre: Rio Acre, Monte Alegre, Seringal São Francisco, Sep 1911, *Ule 9439* (holotype: B, destroyed; isotypes: IAN, K).

Schnella pterocalyx (Ducke) Wunderlin, comb. nov. Basionym: *Bauhinia pterocalyx* Ducke, Arch. Jard. Bot. Rio de Janeiro 3: 109. 1922. **TYPE**: **Brazil**. Amazonas: Rio Purús, near Pôrto Alegre, 8 Apr 1904, *Huber 4401* (holotype: MG; isotypes: BM, G, RB).

Schnella reflexa (Schery) Wunderlin, comb. nov. Basionym: *Bauhinia reflexa* Schery, Ann. Missouri Bot. Gard. 38: 17. 1951. **TYPE**: **Panama**. Canal Zone: vicinity of Salamanca Hydrographic Station, Río Pequení, 28–29 Jul 1938, *Woodson et al. 1623* (holotype: MO!; isotype: NY!, US!).

Schnella riedeliana (Bong.) Wunderlin, comb. nov. Basionym: *Bauhinia riedeliana* Bong., Mém. Acad. Imp. Sci. Saint-Petersbourg, Ser. 6, Sci. Math. Second Pt. Sci. Nat. 4(2): 113. 1836. **TYPE**: **Brazil**. São Paulo: Rio Pardo, Oct 1826, *Riedel 583* (holotype: LE!; isotypes: OXF, P!).

Schnella siqueirae (Ducke) Wunderlin, comb. nov. Basionym: *Bauhinia siqueirae* Ducke, Arch. Jard. Bot. Rio de Janeiro 3: 108. 1922. **TYPE**: **Brazil**. Pará: Peixe-Boi, near Almeirim, between Belém and Bragança, 24 Oct 1907, *Siqueira 8790* (holotype: MG; isotypes: BM!, G!, RB).

Schnella sprucei (Benth.) Wunderlin, comb. nov. Basionym: *Bauhinia sprucei* Benth., in Martius, Fl. Bras. 15(2): 205. 1870. **TYPE**: **Brazil**. Amazonas: near Panuré on Rio Uaupés, Oct 1853, *Spruce 2617* (holotype: K!; isotypes: NY!, OXF, RB).

Schnella stenopetala (Ducke) Wunderlin, comb. nov. Basionym: *Bauhinia stenopetala* Ducke, Bol. Técn. Inst. Agron. N. 36: 60, 70. 1959. **TYPE**: **Brazil**. Amazonas: Lago José Assu, near Parintins, 28 Dec 1935, *Ducke 35433* (holotype: RB; isotype: RB).

Schnella surinamensis (Amshoff) Wunderlin, comb. nov. Basionym: *Bauhinia surinamensis* Amshoff, Meded. Bot. Mus. Herb. Rijks Univ. Utrecht 52: 20. 1939. **TYPE**: **Suriname**. Upper Suriname River near Kabelstation, 8 Nov 1933, *Lanjouw 1152* (holotype: U; isotype: K!, NY!).

Schnella uleana (Harms) Wunderlin, comb. nov. Basionym: *Bauhinia uleana* Harms, Verh. Bot. Vereins Prov. Brandenburg 48: 166. 1907. **TYPE: Peru**. Loreto: Tarapoto, Juan Gerra, Dec 1902, *Ule 6643* (holotype: B, destroyed; isotype: IAN, K!, MG).

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Turner, B.L. 2010. A new species of *Dalea* (Fabaceae) from southernmost Texas. Phytoneuron 2010-50: 1–5. Mailed 3 Nov 2010.

A NEW SPECIES OF *DALEA* (FABACEAE) FROM SOUTHERNMOST TEXAS

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ABSTRACT

A new taxon, **Dalea ceciliana** B.L. Turner, sp. nov., is described from southern Texas, where it is confined to deep sandy soils. It is closely related to the calciphile *D. aurea*, but the two taxa do not co-occur nor do the two populational systems intergrade near regions of contact. A photograph of the holotype is presented, along with a map showing the distributions of the taxa concerned.
KEY WORDS: *Dalea, D. aurea, D. ceciliana*, Texas, Mexico

The present novelty is similar to and clearly closely related to the widespread *Dalea aurea* Nutt. ex Pursh, and it is likely that specimens of the new species were included in the latter by Barneby (1977) in his treatment of the complex, to judge from his statement that "The climatic tolerance of *D. aurea* is exceptional, for it extends in Texas southward out onto the sands of the Gulf Coast Prairie and in Colorado and New Mexico up to the Rocky Mountain piedmont."

The new species described here differs from *Dalea aurea* in its relatively shorter leaflets (1–2 times longer than wide vs. 2–4 times), vestiture of longer hairs, floral bracts lanceolate (vs. ovate) and longer (6–8 mm vs. 3–6 mm) (Fig. 1), and its habitats in the deep sands of southern Texas. The two taxa do not co-occur nor do the two populational systems intergrade near regions of contact (Fig. 2).

DALEA CECILIANA B.L. Turner, **sp. nov.**

Daleae aureae Nutt. similis sed differt foliolis plerumque 1–2-plo longioribus quam latioribus (vs 2–4-plo) trichomatibus fulvis vel brunneis longioribus (1–2 mm vs. minus quam 1 mm), bracteis floralibus lanceolatis 6–8 mm longis (vs. late ovatis 3–6 mm longis), et habitatione solorum arenaceorum profundorum Texas australis (vs. locorum calcareorum plus borealium).

TYPE: **TEXAS. Kenedy Co.**: ca. 2 mi N of Norias, sandy grassy soil, flowers yellow, 10 Jun 1963, *D.S. Correll & D.C. Wasshausen 27632* (holotype: TEX, Fig. 1).

Perennial, multi-stemmed herbs, 30–50 cm high. **Stems** pubescent with upswept tawny hairs 0.8–1.0 mm long. **Leaves** (at mid-stem) 5-foliate, the rachis ca 2 cm long, narrowly winged throughout, the latter glandular-punctate beneath; leaflets ovate to obovate, 1.0–1.5 times as long as wide, pubescent on both surfaces with tawny hairs 1–2 mm long; petioles mostly 5–10 mm long; stipules narrowly lanceolate, ca 2 mm long. **Peduncles** 1–3 cm long, the heads at maturity ca 2 cm wide, 2–7 cm long; bracts lanceolate, 6–8 mm long, 2–3 mm wide, pubescent above, glabrous beneath. **Calyces** 8–9 mm long, the lobes 4–5 mm long, pubescent with tan or tawny (rarely white) hairs 1–2 mm long, the sinuses with 2–4 prominent glands. **Flowers** yellow or rarely "pale pink (*Runyon 2679*, TEX)," the banner 5–6 mm long, flabellate apically, the stipe ca 4 mm long. **Staminal tube** ca 6 mm long, the filaments ca 2 mm long. **Pods** ovate-conical, ca 4 mm high, 2 mm wide.

Representative specimens. **TEXAS. Brooks Co.**: 10 mi N of Encino, 16 Apr 1954, *Johnston 54490* (TEX). **Hidalgo Co.**: 8 mi N of San Miguel, 9 Apr 1944, *Lundell & Lundell 12785* (TEX). **Jim Hogg Co.**: Agua Nueva, Farm Road 1017, 21 Apr 1962, *Johnston 54132* (TEX). **Kenedy Co.**:

15 mi S of Sarita, 12 Jul 1957, *Correll & Johnston 17864* (TEX). **Maverick Co.** (?): (w/o locality), 1 Jul 1931, *Tharp s.n.* (TEX). **Medina Co.**: Deep sandy soil, Carrizo outcrop, 2 mi SW of Devine, 1 May 1954, *Tharp & Turner 3420* (TEX). **Starr Co.**: ca 8.2 road miles NW of jct FM 755 at La Gloria, 4 Apr 2002, *Carr 20589* (TEX). **Willacy Co.**: Yturria Station, 20 Apr 1933, *Runyon 3026* (TEX). **Zapata Co.**: ca 5 mi NE of San Ignacio along county road to Aguilares, 19 May 1980, *Turner 80-70M* (TEX).

In the above citations, the collection from Maverick Co. is queried since Tharp, on the date concerned, also collected in Medina Co. from the sandy Carrizo formation, where *Dalea ceciliana* is known to occur. The taxon has not been collected in Maverick Co. to date, although the Carrizo sands occur in the easternmost portion of that county. Since the plant concerned lacked a specific collection site, I infer that the collector misnumbered the specimen, such errors a well-known habit of the man (pers. observ.).

Dalea ceciliana is named for my long-time friend, Cecilia *nee* Dean (Fig. 3). She served as Secretary of the Botany Department at the University of Texas, Austin, when it was in its "prime" (and when it existed). She married my friend and colleague, Professor Theodore Delevoryas, exceptional paleobotanist and ex Chairman of that Department. Cecilia subsequently divorced the fellow and remarried her second husband Joe Aldez, with whom she currently resides in Austin, Texas.

Cecilia is one of the most altruistic females of my acquaintance and fully deserving of the eponym. Indeed, I have always referred to her as "Saint Cecilia," so much I've admired her intrinsic goodness.

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Figure 1. Holotype of *Dalea ceciliana*.

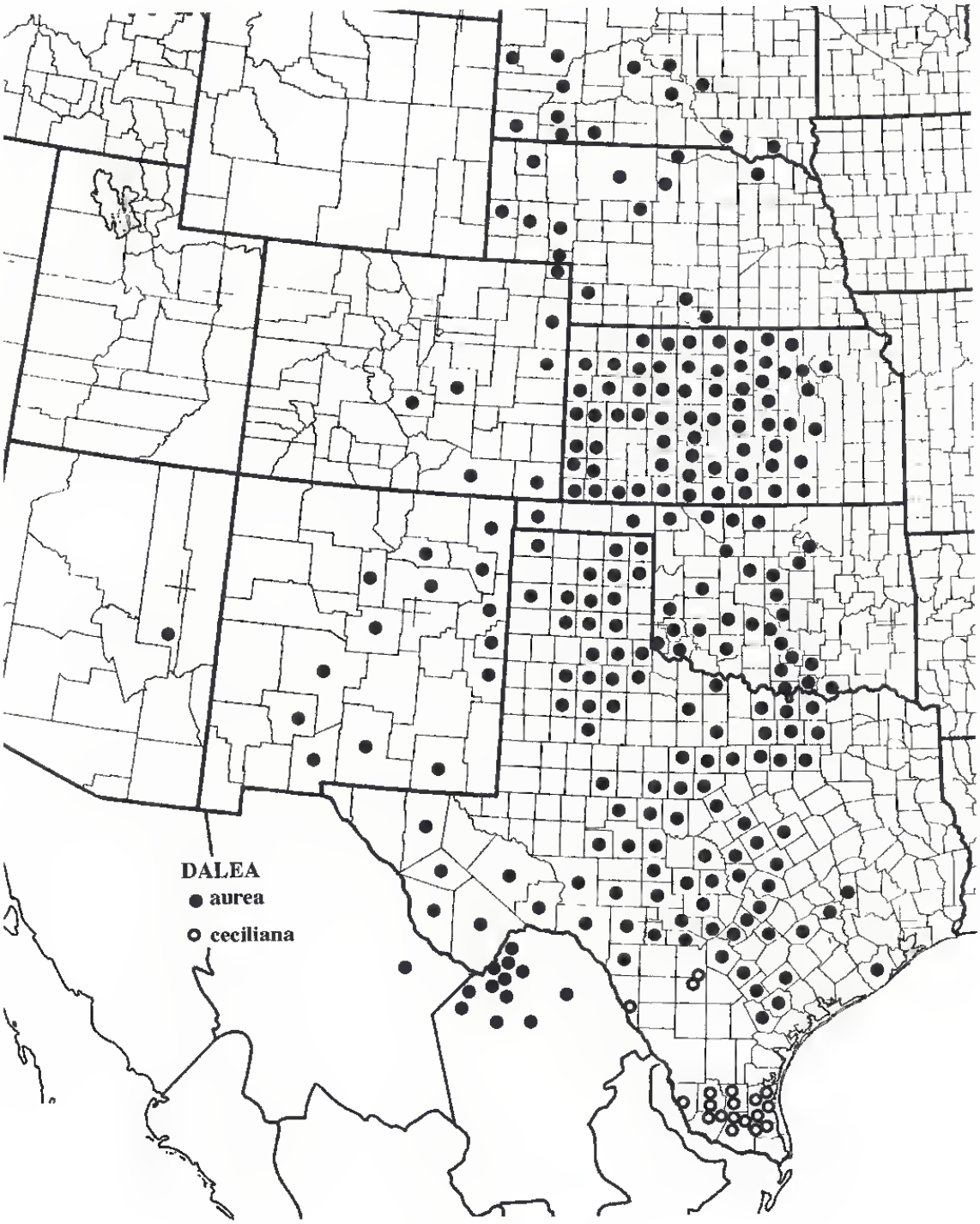

Figure 2. Distribution of *Dalea aurea* and *Dalea ceciliana*.

Figure 3. The eponymee, in Monterrey Mexico, 1983. Photo by Ted Delevoryas.

Nesom, G.L. 2010. *Fraxinus biltmoreana* and *Fraxinus smallii* (Oleaceae), forest trees of the eastern United States. Phytoneuron 2010-51: 1–30.

FRAXINUS BILTMOREANA AND *FRAXINUS SMALLII* (OLEACEAE), FOREST TREES OF THE EASTERN UNITED STATES

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ABSTRACT

Fraxinus biltmoreana Beadle and *Fraxinus smallii* Britton are recognized as species distinct from *F. americana* L., the white ash, closely following an earlier and informal delineation (Santamour 1962). Trees of *F. americana* sensu stricto are diploid, while those of *F. smallii* are tetraploid and those of *F. biltmoreana* are hexaploid. They differ by features of the fruits, leaf and twig vestiture, and shape and thickness of the petiole base; triploid and pentaploid hybrids apparently occur but are uncommon and probably sterile. *Fraxinus americana* (diploid) is more widely distributed to the west and north than the two polyploids, but the latter occur in 20 states of the eastern USA. *Fraxinus smallii* occurs from eastern Texas to Florida, north to Missouri, Ohio, and Pennsylvania; the range of *F. biltmoreana* is similar but it is rare in Arkansas, Louisiana, and Missouri and does not reach Texas. Differences in habitat appear to neglible or non-existent and two or all three of the species sometimes are encountered in close proximity. The distributions of *F. americana*, *F. smallii*, and *F. biltmoreana* are mapped at county level, and synonymy and typifications are provided for all three species. Other maps show the locations from which chromosome counts and estimates have been made. *Fraxinus albicans* Buckley, the Texas ash, and *F. pauciflora* Nutt., the swamp white ash, are similar in leaf morphology to the *F. americana* group and probably all are closely related among themselves.
KEY WORDS: *Fraxinus americana*, *Fraxinus biltmoreana*, *Fraxinus smallii*, *Fraxinus albicans*, *Fraxinus pauciflora*, Oleaceae, white ash

The taxonomic status of *Fraxinus biltmoreana* Beadle has been unsettled almost since its description in 1898, both with respect to its taxonomic rank and its biological reality. It has been treated as a synonym of *F. americana* L., as a variety of it (as *F. americana* var. *biltmoreana* (Beadle) J. Wright ex Fernald), or as a distinct species. Recent study suggests that both it and a closely related, mostly unrecognized entity should be treated at specific rank apart from *F. americana*.

Small (1933) treated *Fraxinus biltmoreana* as a separate species, as did Miller (1955, p. 41–42) in the most recent study of North American ash, who noted that "The presence of a papillose condition on the lower epidermis of the leaflets, coupled with "typical" red ash twigs characterized by acute terminal buds, reniform lateral buds, and truncate leaf scars, serves to distinguish *F. biltmoreana*. The heavy, terete bodies with strictly terminal wings differentiate the samaras from those of any other eastern North American ash, although they resemble most closely the samaras of *F. americana*." Fernald (1950) recognized var. *biltmoreana*, noting the difference in vestiture and also the larger samaras, and var. *biltmoreana* was mapped separately from *F. americana* sensu stricto by Radford, Ahles, and Bell (1968) and Cooperrider (1995).

Wallander (2008) included an arboretum-grown sample of *Fraxinus biltmoreana* in her molecular-phylogenetic study and found that it did not cluster with *F. americana* sensu stricto. She implied that the phyletic disparity might reflect an origin of *F. biltmoreana* as a hybrid between tetraploid *F. americana* and diploid *F. pennsylvanica* Marsh., as earlier hypothesized by Miller (1955). At the end of the description of *F. americana*, Gleason and Cronquist (1991) referred to *F.*

biltmoreana as "a ± pubescent, chiefly southern form, perhaps reflecting hybridization with [*F. pennsylvanica*]."

In contrast, Little (1952) and Hardin and Beckmann (1982) did not recognize *Fraxinus biltmoreana* as formally distinct from *F. americana*. Hardin (1974) treated *F. americana* as a polymorphic species (including *F. biltmoreana*) without segregate species or infraspecific taxa. Schlesinger (1990) observed that white ash is a polyploid species and included *F. biltmoreana* simply as a synonym of *F. americana*; he did not mention the tetraploids with regard to any aspect of variability within the species. Wilson and Wood (1959) noted that "The status of *F. biltmoreana* Beadle is in need of further investigation."

Remarkably, the variation pattern within *Fraxinus americana* sensu lato was accurately described almost 50 years ago by Santamour (1962), built upon earlier discoveries by Wright (1945, 1957) that diploids, tetraploids, and hexaploids were widely distributed through the geographical range of white ash. Santamour found each ploidy level to be distinct in a combination of bud morphology, petiole morphology, and stem and leaf vestiture. He restricted the concept of *F. americana* to the diploids, recognizing the hexaploids and tetraploids together as *F. biltmoreana*. Confirmed here is the observation that the hexaploids and tetraploids, while more similar to each other than is either to *F. americana* sensu stricto (the diploids), are distinct from each other. The concept of *F. biltmoreana* is restricted to the hexaploids and the tetraploids are recognized as *Fraxinus smallii* Britton.

Rationale for recognition of *Fraxinus biltmoreana* and *Fraxinus smallii*.

Most collections of *Fraxinus americana* sensu lato can be identified by morphological features as one of the three ploidal taxa. The geographic range of the diploids (*F. americana* sensu stricto) completely encompasses that of hexaploids as well as the tetraploids and all three occur sympatrically in a large area of east-central USA. (Figs. 1, 2, 3 and 4, 5, 6). Intermediacy is uncommon or rare and thus it appears that the ploidal differences provide effective isolating mechanisms. Hexaploid/tetraploid crosses and tetraploid/diploid crosses would produce pentaploid and triploid offspring, respectively, which presumably would be infertile. It is possible that the tetraploids arose through a cross between *F. biltmoreana* (6x) and *F. americana* (2x), but the present evolutionary independence of the tetraploid entity is indicated by its wider westward geographical distribution (Figs. 2, 3), beyond that of the hexaploid. Further, the tetraploids are characterized by a flavonoid profile that is more than a simple combination of those from *F. americana* and *F. biltmoreana* (see comments below).

Morphological distinction and evolutionary independence (reproductive isolation) are generally regarded as criteria for the recognition of distinct species. Treatment of the sympatric diploids, tetraploids, and hexaploids of white ash at infraspecific rank within a single species does not recognize their apparent genetic isolation, as indicated by their sympatric distribution and non-intergrading morphology. Each of *Fraxinus americana*, *F. biltmoreana*, and *F. smallii* is morphologically distinct and apparently reproductively isolated, and each is treated here as a separate species. *Fraxinus biltmoreana* and *F. smallii* are more similar to each other in morphology and flavonoid profile than is either to *F. americana*. Morphological and molecular differences are discussed in detail below.

Hybrid origin of *Fraxinus biltmoreana* and *Fraxinus smallii*.

The hypothesized evolutionary origin of *Fraxinus biltmoreana* is analogous to that of *F. profunda* (Bush) Bush, also of the eastern USA — both are hexaploids and both are speculated to have originated through hybridization between *F. americana* and *F. pennsylvanica* (Miller 1955; Wright 1965). *Fraxinus profunda* is generally accepted as a distinct species (e.g., Nesom 2010a),

although Miller (1955, p. 47) noted that "it is not clearly differentiated from the red ash [*F. pennsylvanica*] by a group of correlated morphological characteristics, but only by a series of 'gigas' characteristics." Samaras of *F. profunda* are similar to those of *F. smallii* and *F. biltmoreana* — all of large size and with bodies that tend to be dark orange at maturity.

Support in molecular evidence for the hypothesis of hybrid origin of both the hexaploid (*Fraxinus biltmoreana*) and tetraploid (*F. smallii*) white ashes, as well as the distinction of both, was provided in a study of leaf flavonoids by Black-Schaefer and Beckmann (1989). They found that each of the diploid, tetraploid, and hexaploid expressions of *F. americana* sensu lato is distinct in flavonoid profile. The hexaploids and tetraploids produce four compounds present in *F. pennsylvanica* but not in *F. americana* (diploid); on the other hand, three compounds in diploid *F. americana* do not appear in either of the polyploids, and two compounds in the tetraploids and one in the hexaploids do not appear in either *F. americana* or *F. pennsylvanica*. The samples in their study were from "trees in natural populations in central North Carolina;" no vouchers were cited, but these samples apparently were from the same locality as an earlier study (Black & Beckmann 1983), north of Raleigh in Granville County (R.L. Beckmann, pers. comm. 2009).

Morphological evidence for intermediacy of *Fraxinus biltmoreana* between *F. americana* and *F. pennsylvanica* was presented in tabular form by Miller (1955, Table 14). *Fraxinus smallii* is similar to *F. biltmoreana* in intermediacy of the same features. Both of the polyploid white ashes have papillose abaxial epidermal surfaces (Hardin & Beckmann 1982; Williams & Nesom 2010) and terete samara bodies like those of typical *F. americana*; in contrast they have mostly reniform lateral buds and shield-shaped leaf scars with truncate to slightly concave upper margins like *F. pennsylvanica* (compare Fig. 15). In the phylogenetic study by Jeandroz et al. (1997), *F. biltmoreana* is positioned as sister to the western *F. latifolia*.

Why the late recognition of *Fraxinus smallii*?

Prior attention to variation in *Fraxinus americana* has been focused mainly on *F. biltmoreana*, which is conspicuously distinguished by the characteristic vestiture of the twigs and leaves. Except in the comments of Santamour (1962), the tetraploids have been overlooked as an evolutionarily distinct variant, even when *F. biltmoreana* has been recognized as distinct from *F. americana*. The abbreviated form of Santamour's report, without maps, illustrations, or other critical documentation, perhaps led to its limited consideration in subsequent studies and floristic summaries. East of the Mississippi River, where all three of the ploidal expressions occur, observation of the tetraploid has simply been missed, even though it has morphological features of *F. biltmoreana*, except for vestiture, when contrasted with *F. americana*. Descriptions of deeply concave leaf scars in *F. americana* have discounted or ignored the significant variation introduced when the concept of the latter included tetraploids. Avowals that the three ploidy levels are morphologically indistinguishable (e.g., Armstrong 1982; Black & Beckmann 1983) either ignored Santamour's observations or were meant implicitly to take issue with it.

Early studies by Wright perhaps discouraged closer investigation of *F. americana*. He noted (1944a, p. 495) that "the Biltmore ash (*F. biltmoreana*) and the white ash (*F. americana*), now recognized as distinct species differing only in pubescence, need not be separated, either in taxonomy or in silviculture." This reflected his reliance on pubescence as the primary feature for the distinction of Biltmore ash and his observation that various glabrous parental individuals in his study produced pubescent progeny and that from one individual he identified as *F. biltmoreana*, more than half of the progeny were glabrous. "There was a high incidence of pubescence in the progenies of both glabrous and pubescent parents of the southern and intermediate ecotypes." As noted by Miller (1955), however, the progeny evaluated by Wright were only 2 years old, scored for "pubescence of the

petiole and lower surface of the leaf." Santamour (1962) observed that "these seedlings at 2 years probably had not yet developed all their normal morphological traits."

Wright (1944a) concluded that polyploids had developed within *Fraxinus americana* sensu lato only after the differentiation of southern, intermediate, and northern ecotypes, since he found "no evident correlation between the degree of polyploidy and any gross morphological or physiological characters." In contrast, Clausen et al. (1981) were not able to recognize regional ecotypes in *F. americana*, but they did find that "ploidy variation accounted for most of the difference in fruit length, seed width, seedling height, and date of leaf fall."

Chromosome numbers/ploidy levels.

Wright (1944a) solicited seeds of *Fraxinus americana* sensu lato from various localities (each "locality" = "one limited geographical area," characterized in his report only by state and county) and grew progenies of 155 parental trees from 28 localities in 9 states of the eastern USA and Canada. From among these, he made chromosome counts from root tips of seedlings from 24 of the parents; for 39 other parents he estimated the chromosome number from measurements of mean guard cell length. In summarizing the geographic distribution for these 63 reports, he did not distinguish between actual chromosome counts and estimations. To this total of 63, he later added root tip chromosome counts from 9 others (6 diploids, 3 tetraploids) from other localities (Wright 1957). Wright's counts and estimations and their localities are summarized here (Appendix 1a).

Santamour (1962) sampled from one of the several test plantations of white ash earlier established by Wright (1944a) — in the Morris Arboretum in Philadelphia, Pennsylvania — which included "161 trees from 60 mother trees in 12 states throughout the range of *F. americana*." He made root tip chromosome counts that included 8 diploid and 9 tetraploid individuals from among 17 sets of progenies (of the original 60); estimates of ploidy levels, from measurements of guard cell length, of other individuals of each the same progenies agreed with the actual counts. From elsewhere on the Morris Arboretum grounds, Santamour's study of morphology also included trees previously determined by Wright as hexaploid and that "fitted the description of *F. biltmoreana* in all characters, including pubescence."

Schaefer and Miksche (1977) and Leser (1978) studied progeny of trees from 18 states and found diploids, tetraploids, and hexaploids (Appendices 1b, 1c), based primarily on estimates of ploidy level from photometrically determined nuclear DNA content from root tip cells of germinating embryos. Three embryos per tree were combined on a single slide. The estimate from one tree from Clark Co., Indiana, was pentaploid (Schaefer & Miksche 1977) and Leser (1978) also made similar "subhexaploid" estimates from individuals from Indiana, Louisiana, South Carolina, and Tennessee – – the alternative hypothesis that these were dysploid in chromosome number needs to be tested. In a study by Clausen et al. (1981, p. 94, 95), the authors noted that "Seeds were collected from up to 10 native parent trees in each of 59 locations [in five regions of the United States]. … Ploidy levels of 98 parent trees were determined cytophoto-metrically on the basis of DNA content by Schaefer and Miksche (1977) and Leser (1978)." Clausen et al. apparently made no new counts or estimates, apparently basing their study on the combined data of Schaefer and Miksche and Leser.

In connection with a study of wood characteristics of white ash, Armstrong and Funk (1980) made estimates of ploidy from trees from 7 general localities (by county) in 7 states. For the photometric determinations, they used tissue from the bark (phellogen, phelloderm, and cortical cells) of 2-year old seedlings from which they also made wood sections and macerations (see comments below). They found putative diploids, tetraploids, and hexaploids as well as possible triploids and pentaploids (Appendix 1d). Confirmatory chromosome counts were not made.

Black and Beckmann (1983) studied 25 white ash trees from east-central North Carolina (Granville Co.) and found pistillate and staminate individuals of diploids, tetraploids, and hexaploids "within immediate proximity of one another." One tree (no. 15) was estimated to be pentaploid, based on its intermediacy in nuclear DNA value; if this were confirmed, it apparently is the only putative pentaploid mature tree identified in studies that have provided chromosome counts or estimates of ploidy — other pentaploid estimates have come from germinating samaras. Among progeny from one diploid, pistillate, open-pollinated tree was one embryo (of total 30) estimated to be triploid, and among progeny from one open-pollinated tetraploid tree were nine embryos (of total 30) estimated to be pentaploid. Putative triploid and pentaploid seedlings also were grown by Armstrong and Funk (1980). Ploidy levels were estimated in the Black and Beckmann study from photometrically determined nuclear DNA content of leaf tissue, confirmed by chromosome counts from representative individuals (diploid, tetraploid, hexaploid).

Guard cell size was used by Wright (1944a, p. 494) in distinguishing diploids, tetraploids, and hexaploids, after "Preliminary work had shown sufficient correlation between degree of polyploidy and stomata size to make this approximation possible." He did not give cell measurements. Santamour confirmed the stomatal distinction between diploids (guard cell length averaged 16.8 ±1.1 microns) and tetraploids (guard cell length averaged 22.6 ±0.9 microns). Seemingly in contrast to his contemporary paper, Wright (1944b) noted that guard cell size variation in field-grown trees made estimates of ploidy unreliable. Hardin and Beckmann (1982, p. 136) commented that "Stomatal sizes are variable, and although the largest are in the polyploids, there is too much overlap in size to use this as a reliable characteristic for identification of ploidy in natural stands."

Chromosome counts and estimates of ploidy level are summarized in the maps of Figs. 4, 5, and 6, which show the localities (counties) where populations were sampled.

Wood characteristics.

Armstrong and Funk (1980) studied wood of 2-year-old white ash seedlings grown from seeds from various states and found that diploids from the southernmost seed source (Arkansas) produced slightly longer vessel elements and fibers than diploid trees from northern sources. Polyploid individuals produced the longest vessels and fibers.

In a more detailed follow-up, Armstrong (1982) studied wood variation in white ash from southern Illinois from 10 trees, including diploids, tetraploids, and hexaploids, as determined by cytophotometric methods. There were no differences in relative density but both the vessel elements and fibers of the tetraploid and hexaploid trees were longer than those of the diploids. The tetraploid and hexaploid vessel elements were 27% and 43% longer, respectively, and the tetraploid and hexaploid fibers were 18% and 41% longer.

Other differences.

Clausen et al. (1981) found that ca. 2-year-old nursery-grown tetraploids retained their leaves longer and were significantly taller than nursery-grown diploids and hexaploids. Pentaploids and hexaploids had the slowest growth in the nursery.

In a study of seedlings grown in the experimental nursery of the Harvard Forest in Massachusetts, Wright (1944) identified three ecotypes in *Fraxinus americana*, as distinguished by features of winter hardiness, root system morphology, and leaf vestiture and pigmentation: (1) the northern ecotype, from Michigan to central Pennsylvania and New England and northward; (2) the intermediate ecotype, in a narrow belt through southern Pennsylvania, northern West Virginia, and Ohio; and (3) the southern ecotype, all of the eastern USA south of the "intermediate belt." He found that "there were no apparent differences in growth rate, winter hardiness, or morphological characters

which could be associated with the differences in chromosome number." Because the pattern of ecotypic variation seemed to Wright to be developed independently of the ploidal variation, he saw the polyploidy as "of rather recent origin, having arisen since the ecotype differentiation." Wright's conclusions regarding the ecotypical differentiation were not confirmed by Clausen et al. (1981), who noted stronger indication of clinal variation and the effects of ploidy.

Schlesinger (1990) noted other elements of variation: "White ash contains several phenotypic variants of leaf form that appear to be genetically controlled even though they are randomly distributed throughout the natural range. Chief among these are 9-leaflet, narrow-leaflet, blunt-leaflet, ascidiate leaflet, partially pubescent, purple-keyed, and crinkle-leaf forms. A purple leaf variant is vegetatively propagated and grown as an ornamental."

Large-fruited variants in the northeastern USA.

Scattered through New England, westward from Pennsylvania to Indiana, and south along the Appalachian backbone in North Carolina and Tennessee (Fig. 1) are trees of *Fraxinus americana* with glabrous twigs and leaves and the petiole morphology of diploids but with samaras of the same size class as polyploids. These have been mapped as diploids in the present study, weighting the petiole feature, but the biological nature of these individuals is unknown.

Only diploids are known from New England, but too few chromosome counts and estimates have been made to rule out the possibility that these large-fruited trees might be polyploid (distinct in origin from *Fraxinus smallii*?), especially if they are uncommon variants in areas where diploids of typical morphology are common.

***Fraxinus albicans* and *F. pauciflora* share diagnostic features of the *F. americana* group.**

Fraxinus albicans Buckley (synonym = *F. texensis* (A. Gray) Sarg., the Texas ash) is similar to *F. americana* in its papillose abaxial leaf surfaces and samaras with terete bodies and the two have sometimes been treated as conspecific. The taxonomy and distribution of *F. albicans*, as distinct from *F. americana*, are discussed in detail in Nesom (2010b) but variation in samara morphology and leaf scar morphology are shown here (Figs. 7, 13) to contrast with others of the *F. americana* group. A chromosome number has not been reported for *F. albicans* but the relatively small fruits and leaves suggest that it is diploid.

Wallander (2008) found that her two samples of *Fraxinus albicans* (identified as *F. texensis*) grouped with the red ash (*F. pennsylvanica*) complex rather than with any of the *F. americana* samples and thus observed that "presence or absence of epidermal papillae appears not to be phylogenetically informative in [sect. *Melioides*]." The highly distinctive leaf morphology, however, strongly suggests that *F. americana* and its North American relatives comprise a monophyletic group within sect. *Melioides*, and the identy of Wallander's molecular vouchers needs to be confirmed. A morphological survey of the whole genus, including Old World species, at MO indicates that only one other species of *Fraxinus* produces the distinctive features of the abaxial leaf surface.

Fraxinus pauciflora Nutt. of Florida and Georgia also has papillose abaxial leaf surfaces like those of *F. americana* (Nesom 2010c). Two other wetland species of Florida and the southeastern USA, the water ashes *F. caroliniana* Mill. and *F. cubensis* Griseb., appear to be closely related to *F. pauciflora* and the latter is hypothesized to be of hybrid origin, incorporating a white ash genome. The abaxial leaf surfaces of *F. caroliniana* and *F. cubensis* are similar to those of *F. pennsylvanica*, which lack a cuticular overlay.

Description of a papillose abaxial leaf surface in *Fraxinus papillosa* Lingelsh. was based on a different micromorphology than that of *F. americana*. *Fraxinus papillosa* is very closely related to *F. velutina* Torrey (Williams & Nesom 2010), and perhaps not even specifically distinct.

Relationship of *Fraxinus uhdei*.

Fraxinus uhdei (Wenzig) Lingelsh., native to Belize and Guatemala and northward in temperate Mexico to Veracruz, Puebla, and Querétaro, was originally described as a variety of *F. americana* (Wenzig 1883), apparently based on similarities in samara morphology. The abaxial leaf surfaces of *F. uhdei*, however, lack the papillose cuticular structure characteristic of *F. americana* and its presumed closest relatives in eastern North America. In Wallander's phylogenetic reconstruction, *F. uhdei* is a member of sect. *Melioides* and is sister to the red ash complex. Sect. *Melioides*, which is a clearly defined monophyletic group, comprises the white ash and red ash complexes, all taxa of which are native to North America.

Key to the species of the *Fraxinus americana* group.

Morphology of samaras and petiole bases/leaf scars is shown in Figs. 7–9 and 10–13.

1. Trees of swamp habitats; samara wings arising from near base of body ..... **Fraxinus pauciflora**
1. Trees of upland habitats; samara wings arising from distal portion of body.

2. Leaflet blades mostly 3–6(–8) cm, suborbicular-ovate to obovate, oblong-ovate, or elliptic, apex abruptly acute to rounded, base rounded; rachis (1–)2–6(–7) cm; leaf scars 2.5–3(–4) mm wide ..... **Fraxinus albicans**
2. Leaflet blades mostly 5.5–12(–15) cm, ovate to ovate-lanceolate or elliptic-lanceolate, apex acute-acuminate or less commonly obtuse, base cuneate to rounded; rachis 4–12 cm; leaf scars 3–4 mm wide.

3. Petiole bases and leaf scars V- to U- or crescent-shaped with a deeply concave or notched apex; samaras (19–)25–32(–38) mm, wings 3–5(–6) mm wide, bodies (5–)6–11 x 1.5–2.5 mm; twigs, petioles, petiolules, and rachises glabrous ..... **Fraxinus americana**
3. Petiole bases and leaf scars oblong-obovate to widely obovate with a nearly truncate apex; samaras (32–)33–54 mm, wings (4.5–)5–8 mm wide, bodies (7–)10–15 x 2–4 mm; twigs, petioles, petiolules, and rachises glabrous or hirtellous to hirtellous-puberulent to tomentulose.

4. Twigs, petioles, petiolules, and rachises glabrous; samaras (32–)36–44 mm, wings (4.5–)5–7 mm wide, bodies (9–)10–13 x 2–3.5 mm ..... **Fraxinus smallii**
4. Twigs, petioles, petiolules, and rachises sparsely to densely hirtellous to hirtellous-puberulent or tomentulose; samaras 33–54 mm, wings 6–8 mm wide, bodies (7–)11–15 x 2–4 mm ..... **Fraxinus biltmoreana**

Comments on identification.

The most easily observable diagnostic feature among the upland taxa is the vestiture of *Fraxinus biltmoreana*, where the twigs, petioles, and leaf rachises are densely puberulent-tomentose (Fig. 12). Those of *F. americana* and *F. smallii* are glabrous to glabrate (Figs. 10, 11). In my observations, the correlation has been perfect between puberulent vestiture and the characteristic petiole base and samara size of the polyploids, apparently confirming the observations of Small, Fernald, Miller, Santamour, and others as noted above.

Wright (1944), however, made apparently contradictory observations regarding vestiture and concluded that *Fraxinus biltmoreana* could not justifiably be recognized as a distinct species. In observations of petioles and abaxial leaf surfaces of 2-year-old seedlings, he found that more than half

of the seedlings among progeny of a pubescent parent from Indiana were glabrous. Similarly, he encountered pubescent progeny among seedlings from glabrous parents. Miller (1955) and Santamour (1962) reckoned that this unexpected variation (compared to the pattern predicted in mature trees) was associated with the juvenile nature of the seedlings studied by Wright.

The petiole bases and leaf scars in *Fraxinus americana* are V- to U- or distinctly crescent-shaped, with the lateral buds situated in the deep notch of the petiole base (Fig. 10). In *F. smallii* and *F. biltmoreana* the petiole bases and leaf scars are oblong-obovate to widely obovate with a nearly truncate apex, with the lateral buds at the top of the nearly truncate petiole base (Figs. 11, 12). This feature is particularly useful as it appears to consistently separate the glabrous diploids (*F. americana*) and tetraploids (*F. smallii*), especially when fruits are not available.

Bud morphology has been used in some discussions as a feature diagnostic among these species (e.g., especially Miller 1955). Terminal buds of *Fraxinus americana* are said to be "obtuse, ovoid" — vs. apiculate in *F. biltmoreana*, lateral buds of *F. americana* triangular and apically acute – – vs. rounded to reniform in *F. biltmoreana*. These distinctions, however, appear to be subtle and apparently not consistent enough for diagnostic use.

Contrasts in samara morphology between *Fraxinus americana* and *F. smallii* in Texas, Louisiana, and Arkansas are shown in Fig. 8. Samaras of *F. americana* from east of the Mississippi River appear to be slightly more variable in size; those from the northeastern USA perhaps are of two size classes (see comments above). Collections unambiguously identified as *F. biltmoreana* show samaras (Fig. 9) similar to those of *F. smallii*. In samaras of the tetraploids and hexaploids, wings are longer and wider and the bodies thicker compared to typical (diploid) *F. americana*.

Leser (1978) found that the average weight of hexaploid samaras was distinctly greater than that of the diploids, reflecting the evident difference in size. Average weight of the tetraploid samaras was intermediate between the diploid and hexaploid but, perhaps because of the low sample size for tetraploids in Leser's study, the differences were not statistically significant.

Taxonomy.

FRAXINUS SMALLII Britton, N. Amer. Trees, 805, f. 735. 1908. **TYPE**: USA. Georgia. Gwinnett Co.: Yellow River near McGuire's Mill, 750 feet, 2 Aug 1895, *J.K. Small s.n.* (holotype: NY! digital image!; isotype: GH!). Annotated as "*Fraxinus americana* L." by G.N. Miller, 25 May 1951.

Fraxinus americana var. *subcoriacea* Sargent, Bot. Gaz. 67: 241. 1919. **SYNTYPES**: USA. Massachussetts. Suffolk Co.: Boston, cultivated at the Arnold Arboretum in Jamaica Plain, 10 Oct 1905, collector not specified (AA 283679!, AA 73800!).

The protologue: "What may be considered the type of the variety has been growing in the Arnold Arboretum since 1874, where it was raised from seed sent by W.C. Hampton from Mount Victory, Harding County, Ohio, as 'Fraxinus C'."

In reference to var. *subcoriacea*, Sargent noted in the protologue that "The trees of this variety have grown more rapidly and are handsomer than any of the other American ashes in the collection. … These trees are so distinct in appearance and in their more rapid vigorous growth that it seems desirable to give them a varietal designation. … Individual trees of *F. americana* occur with thick, oblong-ovate, acuminate, entire or slightly serrate leaflets dark green and lustrous above, silvery white below, glabrous or slightly villous along the midribs, and 7.5–13 cm long."

Sargent (1922, p. 842) apparently mistakenly referred in text to this taxon as "var. crassifolia," citing the same type and paratypes as for var. *subcoriacea*.

Trees 7–20 m; twigs terete, glabrous; bark light to dark gray, evenly furrowed with smooth ridges and evenly reticulate; winter buds brown. **Leaves** deciduous, pinnate, 20–35 cm; leaflets 7–9, subcoriaceous, petioles, rachis, and petiolules glabrous, abaxially whitish to pale greenish, papillose, not scaly-punctate, blade 7–12 x 2.5–7 cm, ovate-lanceolate to narrowly ovate-lanceolate, elliptic-ovate, or oblong-ovate, apex acute to long-acuminate, base rounded to obtuse or abruptly attenuate, margins entire or usually subentire to very shallowly crenate, lateral petiolules 3–20 mm, not winged; rachis 7–12 cm, not winged; petiole bases not raised; leaf scars oblong-obovate to widely obovate, apex, shallowly concave to nearly truncate. **Flowers** unisexual (species dioecious), appearing with or just before leaves, wind pollinated; pistillate calyx present, persisting at base of samaras; petals absent. **Samaras** (32–)36–44 mm, body cylindric to subcylindric, wings 2, arising from distal 1/3–1/4 of body, (4.5–)5–7 mm wide. $2n = 92$.

Flowering Feb–Apr(–May). Bottomland forests, alluvial woods, creek terraces, flood plains, sandy swales, slopes, ridges, river bluffs, loess hills, beech-maple, upland hardwoods, oak-pine; 100–400(–1200, in Rabun County, Ga.) m; Ala., Ark., Fla., Ga., Ill., Ind., Ky., La., Md., Miss., Mo., N.J.?, N.C., Ohio, Okla.?, Pa., S.C., Tenn., Tex., Va.

Collections examined from **Texas**. **Bowie Co.**: near Texarkana, 3000 ft, 3 Sep 1898, *Heller 4206* (GH-2 sheets, NY); Texarkana, sandy bog near Texarkana, 16 Apr 1926, *Palmer 29666* (GH). **Newton Co.**: 23 Jul 1952, *Tharp & Gimbrede 52-627* (OKLA, TEX). **Polk Co.**: Livingston, sandy woods, 10 Apr 1914, *Palmer 5166* (GH). In the protologue of *Fraxinus americana* var. *subcoriacea*, Sargent noted "*Fraxinus americana* no. 4206, A. and E.G. Heller, Texarkana, Texas, September 1898, with entire and equally thick leaflets but not so pale below, is probably the same form."

FRAXINUS BILTMOREANA Beadle, Bot. Gaz. 25: 358. 1898. *Calycomelia biltmoreana* (Beadle) Nieuwland, Amer. Midl. Naturalist 3: 186. 1914. *Fraxinus americana* var. *biltmoreana* (Beadle) J. Wright ex Fernald, Rhodora 49: 159. 1947. *Fraxinus americana* subsp. *biltmoreana* (Beadle) A.E. Murray, Kalmia 13: 6. 1983. **TYPE**: USA. North Carolina. [Buncombe Co.:] Biltmore, Oct 1895, [*C.D. Beadle*] *No. 4049* (probable holotype: US-digital image!). The protologue says only "Biltmore herbarium, no. 4049, Biltmore, N.C. type locality." A collector is not specifically noted on the label, but "No. 4049" and "Type" are handwritten on a label with printed "Biltmore Herbarium" as heading. A separate annotation reads "Presented in 1917 by Mrs. George W. Vanderbilt." Sheets at GH and NY, with the collector and number specified as C.D. Beadle, No. 4049 (4049^a, 4049^b, 4049^c), were collected in 1897 and can be regarded as topotypes. A sheet labeled as 4049^a (NY) was collected 2 Oct 1897.

Fraxinus catawbiensis Ashe, Bot. Gaz. 33: 230. 1902. **TYPE**: USA. North Carolina. [Granville Co.:] Eclipse P.O., bank of Catawba River at farm of Mr. Bird, 7 Aug 1901, *W.W. Ashe s.n.* (holotype: NCU!). In the protologue, Ashe noted that "It is closely related to the white ash, from which it is separated by the darker foliage, glaucous white beneath, the soft pubescence of the twigs and petiole, and the darker winter-buds; while from *Fraxinus biltmoreana* and *F. profunda*, which it closely resembles in foliage and pubescence, it is separated by the shorter and smaller fruit and smaller calyx."

Trees, 8–35 m. **Stems**: twigs terete, sparsely to densely hirtellous to hirtellous-puberulent or tomentulose; bark light to dark gray, evenly furrowed with smooth ridges and evenly reticulate. **Winter buds** brown. **Leaves** deciduous, pinnate, 20–35 cm; leaflets 7–9, abaxially whitish to pale greenish, subcoriaceous, papillose, not scaly-punctate, petioles, rachis, and petiolules sparsely to densely hirtellous to hirtellous-puberulent or tomentulose; blade ovate to ovate-lanceolate, elliptic-ovate, or elliptic-oblong, (6–)8–11(–15) x (2.5–)3.5–6(–7.5) cm, base rounded to truncate or obtuse, margins entire or usually subentire to very shallowly crenate, apex acute to acute-acuminate, lateral

petiolules 3–15 mm, not winged; rachis 4–12 cm, not winged; petiole bases not raised; leaf scars oblong-obovate to widely obovate, apex shallowly concave to nearly truncate. **Flowers** unisexual (species dioecious), appearing with or just before leaves, wind pollinated; pistillate calyx present, persisting at base of samaras; petals absent. **Samaras** 33–54 mm, body cylindric to subcylindric, wings 2, arising from distal 1/3–1/4 of body, 6–8 mm wide. ***2n*** = 138.

Flowering Apr–May. Bluffs, rocky slopes, mesic woods, river and creek banks and terraces, woods margins, rocky woods, maple-post oak slopes, pastures; 50–1100 m; Ala., Ark., Ga., Ill., Ind., Ky., Md., Miss., Mo., N.J., N.C., Ohio, Pa., S.C., Tenn., Va., W.Va.

Fraxinus biltmoreana is rare west of the Mississippi River (Fig. 3). There is an enclave of the species in southeastern counties of Missouri, at the apparent western edge of the range of the species. Records in Arkansas and Louisiana appear to be rare and disjunct from the main geographic range, but the occurrence of hexaploids in both states is confirmed in Arkansas by a chromosome count from Pope County (Wright 1957) and a ploidy estimate from Boone County (Armstrong & Funk 1980) and in Louisiana by a estimate from East Baton Rouge Parish (Leser 1978).

Specimen examined from **Arkansas**. **Clark Co.**: Little Missouri River bottoms, 220 ft, Gurdon P.O., 6 Jun 1973, *Demaree 66612* (SMU). This individual is characterized by features typical of *Fraxinus biltmoreana*: large fruits, shallowly concave leaf scars, and puberulent stems, petioles, rachises, and petiolules.

FRAXINUS AMERICANA L., Sp. Pl. 2: 1057. 1753. *Calycomelia americana* (L.) Kosteletzky, Allg. Med.-Pharm. Fl. 3: 1004. 1834. **LECTOTYPE** (Fernald 1946, p. 391, plate 3): [*Clayton 742*,] Herb. Linn. No. 1230.3 (LINN digital image!, photo-NY!; isolectotype: BM digital image!). The Catesby plate cited by Linnaeus depicts *Fraxinus caroliniana* Miller; in order to maintain the traditional association of the epithet, Fernald selected as lectotype a specimen in the Linnaean herbarium that is an incomplete leaf — the petiole base is not included, and of the 4 pairs of large leaflets, 3 of them are missing the opposite leaflet. The associated label reads "Fraxinus femina foliis utrinque acuminatis seminibus alatis pendulis vid. Catesb. N. Hist. tab. 8a Clayton n. 742." The BM specimen also is a single leaf, missing several leaflets but showing a U-shaped petiole base and confirming the identity as *F. americana* sensu stricto (diploid). The LINN sheet has no collection information; the BM is more complete and includes an indication of "Clayton 742."

Fraxinus curtissii Vasey, Cat. Forest Trees U.S., 20. 1876. *Fraxinus americana* var. *curtissii* (Vasey) Sudw., U.S. Div. Forest. Bull. 14: 327. 1897. **TYPE**: USA. Alabama. [Barbour Co.:] Eufaula, [Chattahoochi R., Aug 1875,] *A.H. Curtiss s.n.* (holotype: US digital image!; isotype: GH!). The protologue: "Southern States. Mr. Curtiss found at Eufala, Ala., a large ash with remarkably small fruit. This species is provisionally called *F. curtissii*. It requires further investigation." *Fraxinus curtissii* apparently is homotypic with *F. americana* var. *microcarpa*. The type specimen has a handwritten annotation by Asa Gray as "*F. americana* var. *microcarpa*" — see below.

Fraxinus americana var. *microcarpa* A. Gray, Syn. Fl. N. Amer. 2(1): 75. 1878. **TYPE**: USA. Alabama. [Barbour Co.:] Eufala, Chattahoochi R., Aug 1875, *A.H. Curtiss s.n.* (holotype: GH!; isotype: US digital image!). The protologue cites *F. albicans* and *F. curtissii* in synonymy: "*F. albicans*, Buckley in Proc. Acad. Philad. 1862, partly. *F. curtissii*, Vasey, Cat. Trees U.S. 20." See comments regarding the name *Fraxinus albicans* in Nesom (2010b).

Fraxinus americana forma *todocarpa* Fernald, Rhodora 14: 192. 1912. *Fraxinus americana* var. *todocarpa* (Fernald) Fernald ex Rehder, in L.H. Bailey, Stand. Cycl. Hort., 1275. 1915. **SYNTYPES**: USA. Massachusetts. Middlesex Co.: Winchester, bank of Mystic Lake, 17 Jun

1911, *F.F. Forbes and M.L. Fernald s.n.* (GH 00219144!, GH 00219143!). Maine. [Kennebec Co.:] Gardiner, 13 Jun 1911, *J.M.H. Morrell s.n.* (GH!).

Trees, (5–)15–30(–40) m. **Stems**: twigs terete, glabrous; bark light to dark gray, evenly furrowed with smooth ridges and evenly reticulate. **Winter buds** brown. **Leaves** deciduous, pinnate, 15–30(–35) cm; leaflets 5–9, abaxially whitish to pale greenish, dark green adaxially, subcoriaceous, papillose, not scaly-punctate, glabrous or short-villous abaxially when young, especially along midrib and laterals; blade ovate to ovate-lanceolate, elliptic-lanceolate, or oblong-elliptic, 5.5–12(–15) x (2–)2.5–6(–7.5) cm, base cuneate to rounded, margins usually entire to shallowly crenate serrate on distal 3/4, apex acute to acute-acuminate or less commonly obtuse, lateral petiolules 4–13(–15) mm, not winged; rachis 5–10 cm, not winged; petiole bases not raised; leaf scars V- to U- or crescent-shaped, apex deeply concave or notched. **Flowers** unisexual (species dioecious), appearing with or just before leaves, wind pollinated; pistillate calyx present, persisting at base of samaras; petals absent. **Samaras** (19–)25–32(–38) mm, body cylindric to subcylindric, wings 2, arising from distal 1/3–1/4 of body, 3–5(–6) mm wide. $2n = 46$.

Flowering Feb–Apr(–May). Creek sides and alluvial terraces, flood plains, hammocks, low woods, mesic woods, coves, dry hills; 50–1200(–1500) m; N.B., N.S., Ont., P.E.I., Que.; Ala., Ark., Colo., Conn., Del., D.C., Fla., Ga., Ill., Ind., Iowa, Kans., Ky., La., Maine, Md., Mass., Mich., Minn., Miss., Mo., Nebr., N.H., N.J., N.Y., N.C., Ohio, Okla., Pa., R.I., S.C., Tenn., Tex., Vt., Va., W.Va., Wis.; introduced in Europe (England, Hungary), Africa, Pacific Islands (Hawaii), Australia.

Postscript.

The current report is primarily a review and synthesis of previous research on the *Fraxinus americana* group. It also provides documentation for the briefer taxonomic treatment of the genus in a forthcoming volume of the Flora of North America. Perhaps most significantly, and hopefully, this presentation may serve as a stimulus toward further research. Among significant taxonomic questions to be answered regarding white ash taxonomy are these.

* Are the tetraploid and hexaploid taxa hybrid in origin, and if so what are the parents? Did the tetraploid and hexaploids each have a single and independent origin?

* Putatively triploid and pentaploid individuals have been encountered as embryos, but are triploid and pentaploid trees common or rare in nature?

* What is the biological nature of these trees with large, polyploid-sized fruits but with diploid petiole morphology (as mapped in Fig. 1)? Are they ecotypic variants, or are they a lineage distinct from the sympatric diploid trees with typical-sized fruits? Diploid or polyploid?

* What is the relationship of *Fraxinus albicans*, the Texas ash, to *F. americana*?

* What is the relationship of *Fraxinus pauciflora*, the swamp white ash, to the upland forest trees of the white ash group? Is it of hybrid origin, and if so what are its parents?

Typifications of various names potentially allied with the white ash group (and also the green ash group) remain to be formally clarified. A manuscript on this is in preparation, to be published separately.

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I am grateful to the staffs of BRIT-SMU, GH, MO, NLU, NY, OKL, OKLA, TEX-LL, UCA (Conway), and VDB for help and hospitality during studies there, to Alan Weakley and Eva Wallander for helpful comments, and to Alan Weakley, Jim Henrickson, and MBG Library staff for

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Appendix 1. Chromosome number counts and estimations by Wright (1944a, 1957), Schaefer & Miksche (1977), Leser (1978), and Black & Beckmann (1983). States and counties/parishes.

1a. Chromosome number counts and estimations by Wright (1944a, 1957).

2n = 46

Indiana	Decatur (NEG-788), Marion (NEG-789, NEG-797), Ripley (NEG-799)
Maryland	Washington
Massachusetts	Berkshire (NEG-400)
Ohio	Hocking, Muskingum, Wayne
Pennsylvania	Berks, Lancaster, Montgomery (NEG-393), Schuylkill, Westmoreland, York
Tennessee	Anderson (NEG-811)
West Virginia	Marshall, Pocahontas

2n = 92

Alabama	Chilton, Marion
Arkansas	Pope (NEG-773)
Indiana	Decatur (NEG-785), Greene
Maryland	Washington
Ohio	Wayne
Pennsylvania	Lancaster, Montgomery (NEG-391, NEG-392), Westmoreland

2n = 136

Alabama	Chilton
Arkansas	Pope
Indiana	Greene, Owen
Maryland	Washington
Pennsylvania	Lancaster
West Va.	Marshall

1b. Chromosome number counts and estimations by Schaefer & Miksche (1977). Localities are deduced from the latitude/longitude coordinates provided by the authors.

2n = 46

Arkansas:	Marion
Connecticut:	New Haven
Illinois:	Effingham, Gallatin, Jackson
Kentucky:	Scott
Maine:	Hancock
Michigan:	Washtenaw
Mississippi:	Greene, Oktibbeha
New York:	Cayuga, Essex
North Carolina:	Henderson
Ohio:	Warren, Wayne
Tennessee:	Franklin
West Virginia:	Tucker
Wisconsin:	Langlade

2n = 92

Louisiana:	East Baton Rouge
Mississippi:	Oktibbeha
Texas:	Hardin

2n = 136

Ohio:	Warren
Kentucky:	Scott
Illinois:	Gallatin, Jackson
Indiana:	Clark
North Carolina:	Henderson, Wake

pentaploid?

Indiana:	Clark

1c. Chromosome number counts and estimations by Leser (1978).

2n = 46

Alabama:	Madison
Illinois:	Gallatin, Jackson, Union, Williamson
Kentucky:	Lyon, Trigg
Mississippi:	Oktibbeha
North Carolina:	Chatham, Orange
Ohio:	Warren
Tennessee:	Franklin, Fentress, McMinn, Overton

2n = 92

Louisiana:	East Baton Rouge
Texas:	Hardin

2n = 136

Illinois:	Jackson, Saline, Union
Indiana:	Crawford, Jackson, Washington
Louisiana:	East Baton Rouge
South Carolina:	Pickens
Tennessee:	Smith

pentaploid?

Indiana:	Crawford-Jackson-Washington (6795)
Louisiana:	East Baton Rouge (6738)

South Carolina: Pickens (6784)
Tennessee: Overton-Fentress-Smith (6864)

1d. Chromosome number estimations by Armstrong and Funk (1980).
2n = 46
New Brunswick: Northumberland
Vermont: Addison
New York: Onondaga
Ohio: Warren

2n = 92
Illinois: Jackson-Union-Williamson (mapped as Jackson)
Indiana: Harrison-Washington-Jackson (mapped as Washington)

2n = 136
Arkansas: Marion-Boone (mapped as Boone Co.)

triploid?
Indiana: Harrison-Washington-Jackson (not mapped)

pentaploid?
Indiana: Harrison-Washington-Jackson (not mapped)

1e. Chromosome number counts and estimations by Black & Beckmann (1983).
2n = 46
North Carolina: Granville

2n = 92
North Carolina: Granville

2n = 136
North Carolina: Granville

triploid?
North Carolina: Granville

pentaploid?
North Carolina: Granville

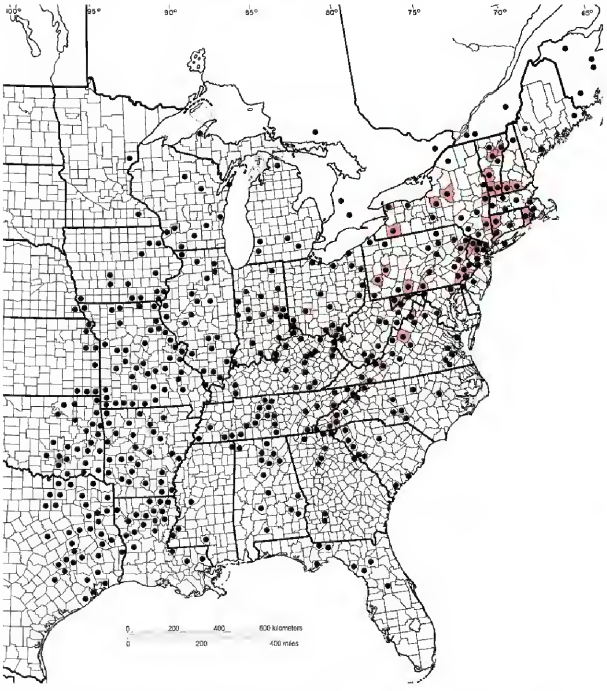

Figure 1. Geographic distribution of *Fraxinus americana* sensu stricto. Shaded counties are those from which large-fruited but "diploid-petioled" collections (see text) have been seen. In Canada, white ash also occurs in Nova Scotia and on Prince Edward Island (not mapped).

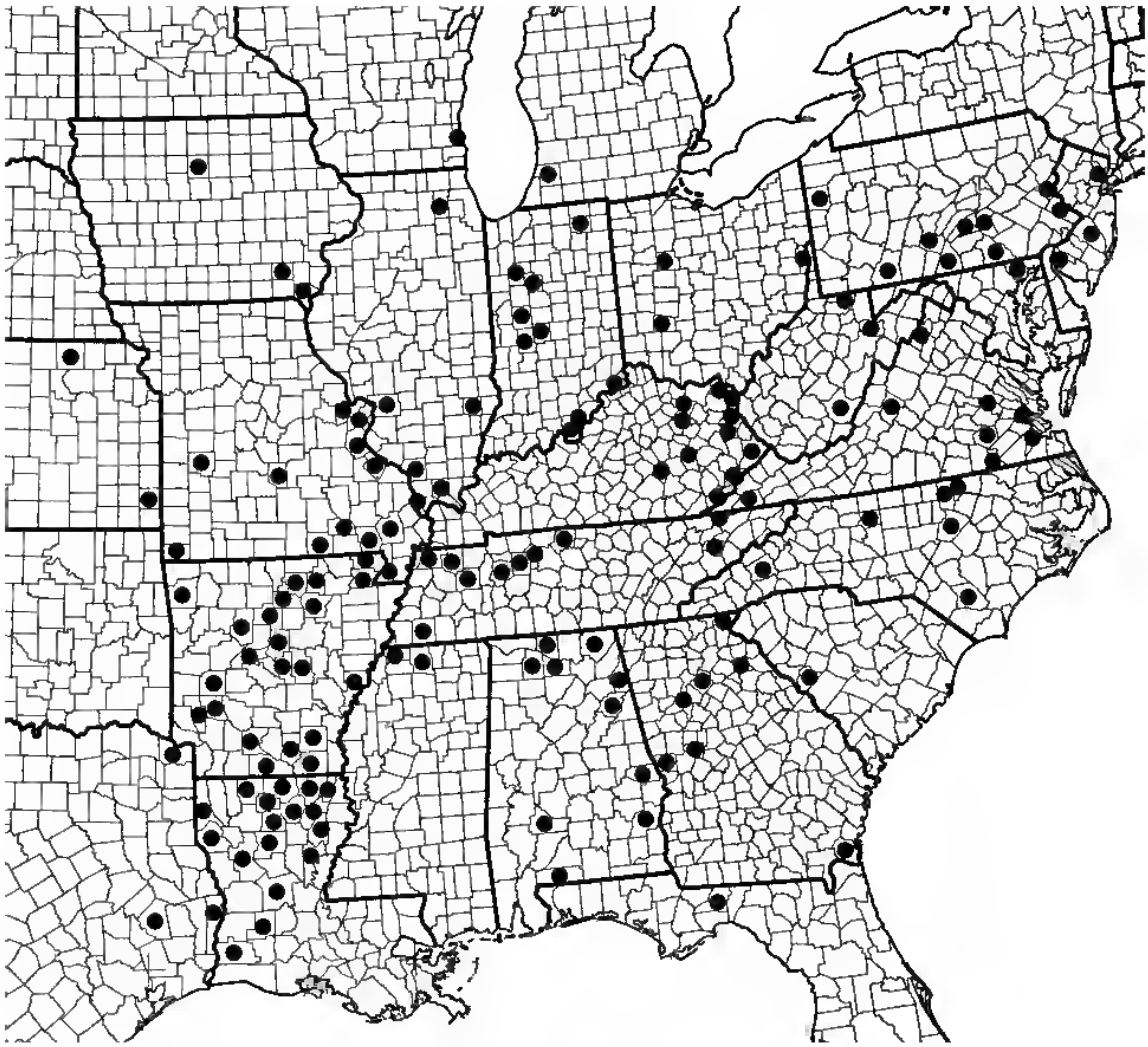

Figure 2. Geographic distribution of *Fraxinus smallii*.

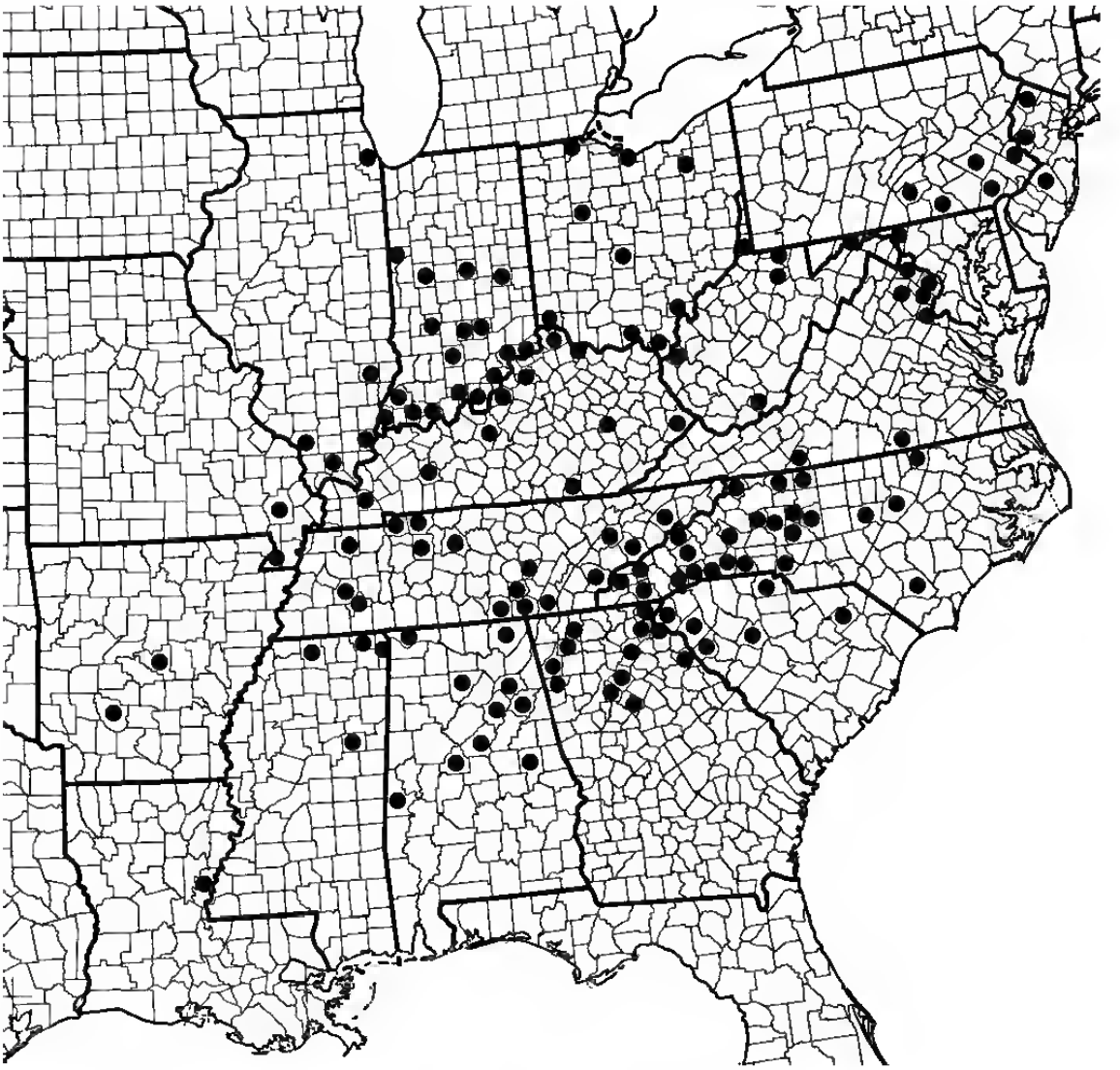

Figure 3. Geographic distribution of *Fraxinus biltmoreana*. Map points have been added from the online atlas for the "NCU Flora of the Southeastern United States," based on specimens at NCU (http //www herbarium unc edu/seflora). Chromosome counts and ploidy estimates from cytophotometry corroborate the presence of *F. biltmoreana* in Arkansas and Louisiana.

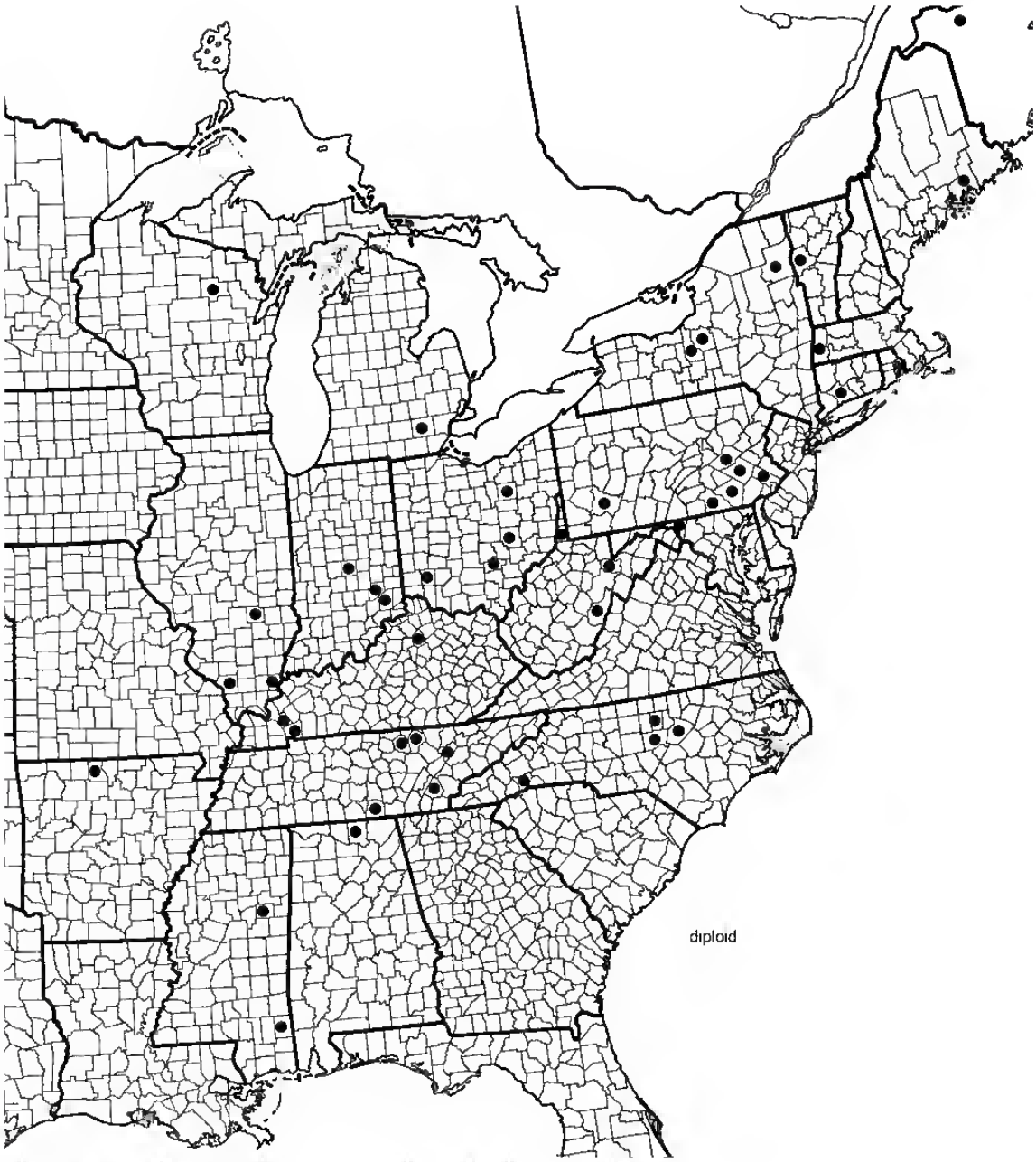

Figure 4 *Fraxinus americana* sensu stricto, diploid — localities for reported chromosome counts and estimations See Appendix 1 for documentation

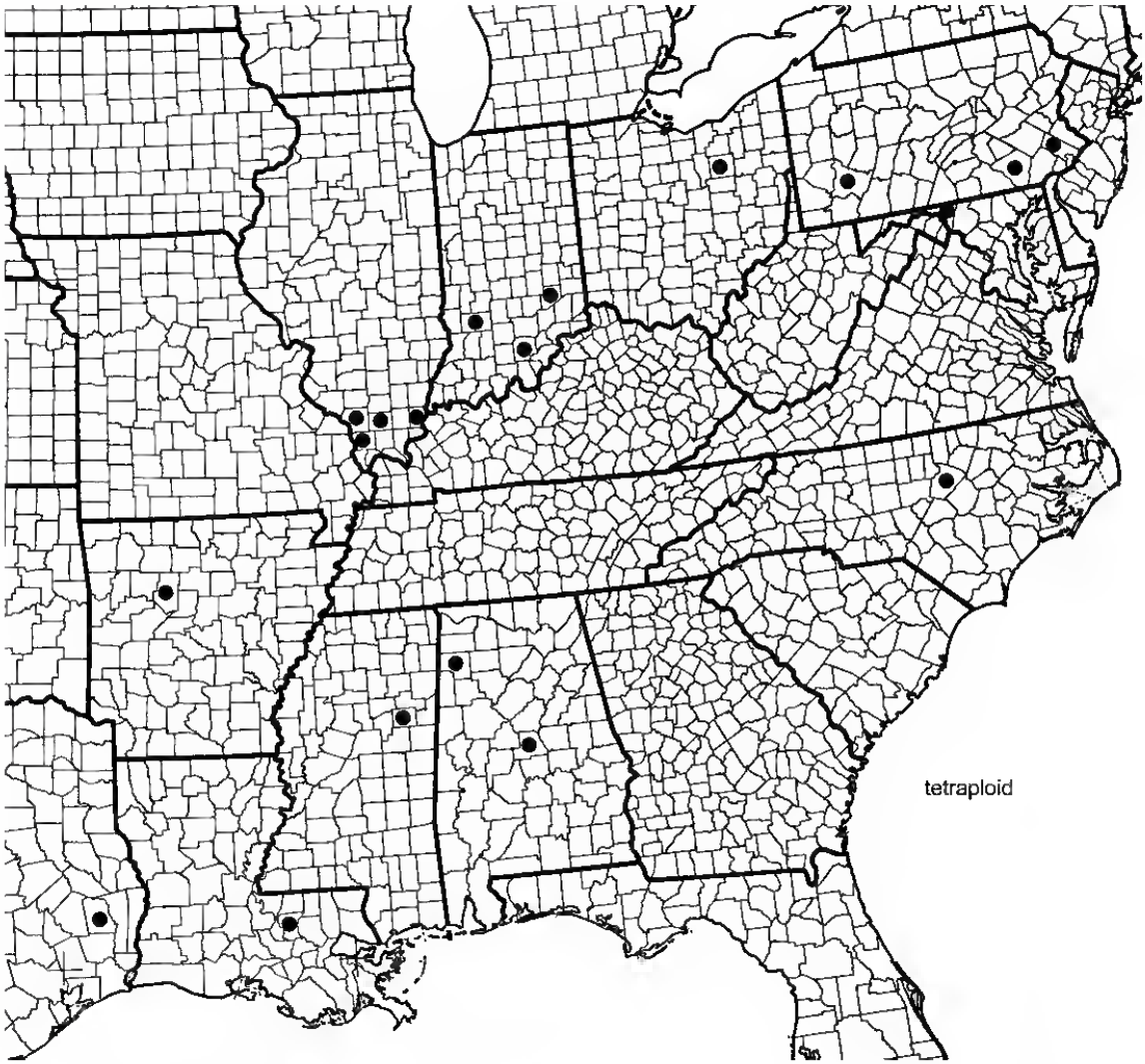

Figure 5. *Fraxinus smallii*, tetraploid — localities for reported chromosome counts and estimations. See Appendix 1 for documentation

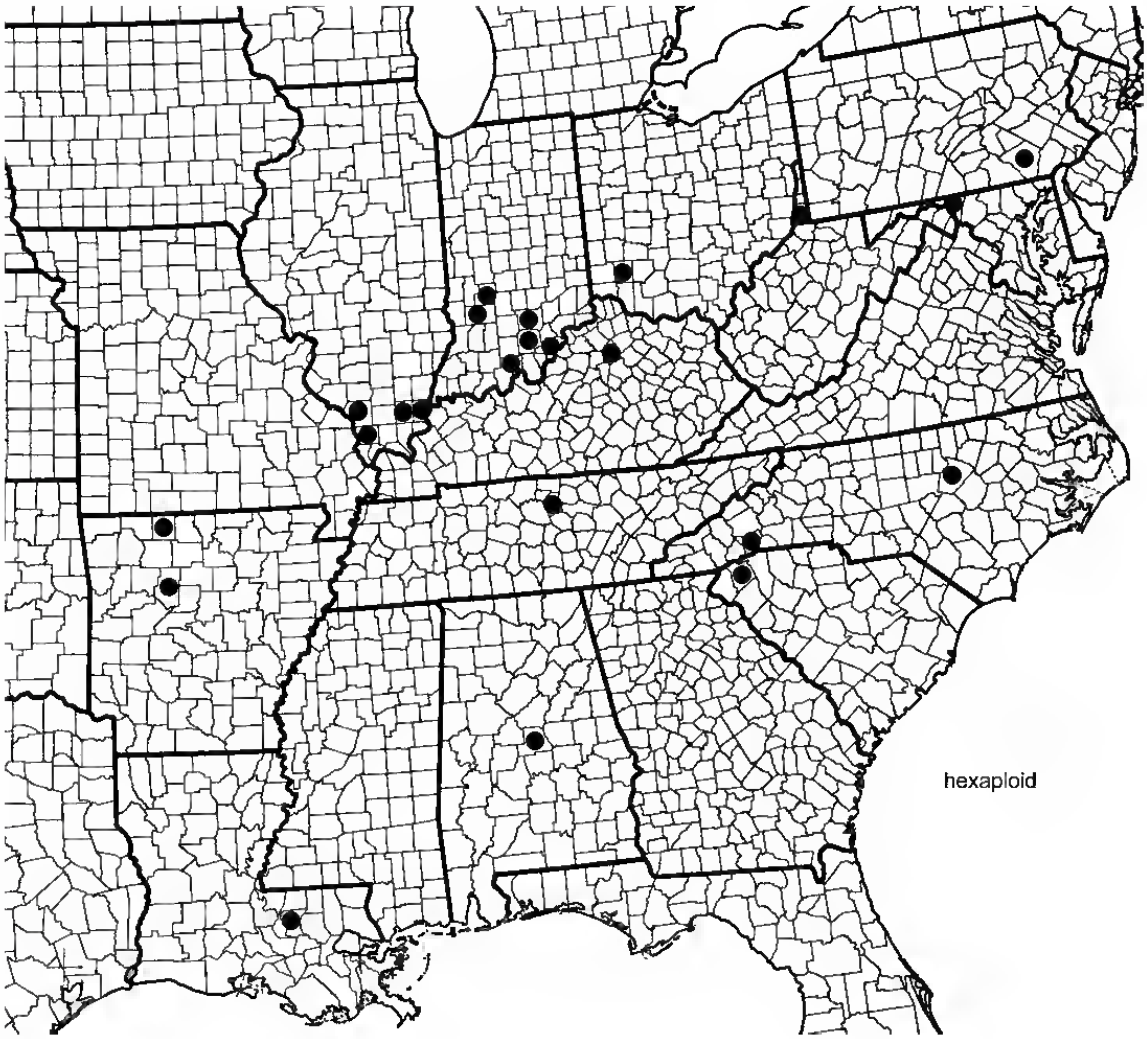

Figure 6. *Fraxinus biltmoreana*, hexaploid — localities for reported chromosome counts and estimations. See Appendix 1 for documentation.

Figure 7 Samara variation in *Fraxinus albicans* and *F americana* Top two rows Texas ash (*Fraxinus albicans*) in Texas and Oklahoma Bottom two rows typical diploid white ash (*Fraxinus americana*) in Texas Oklahoma, and Louisiana

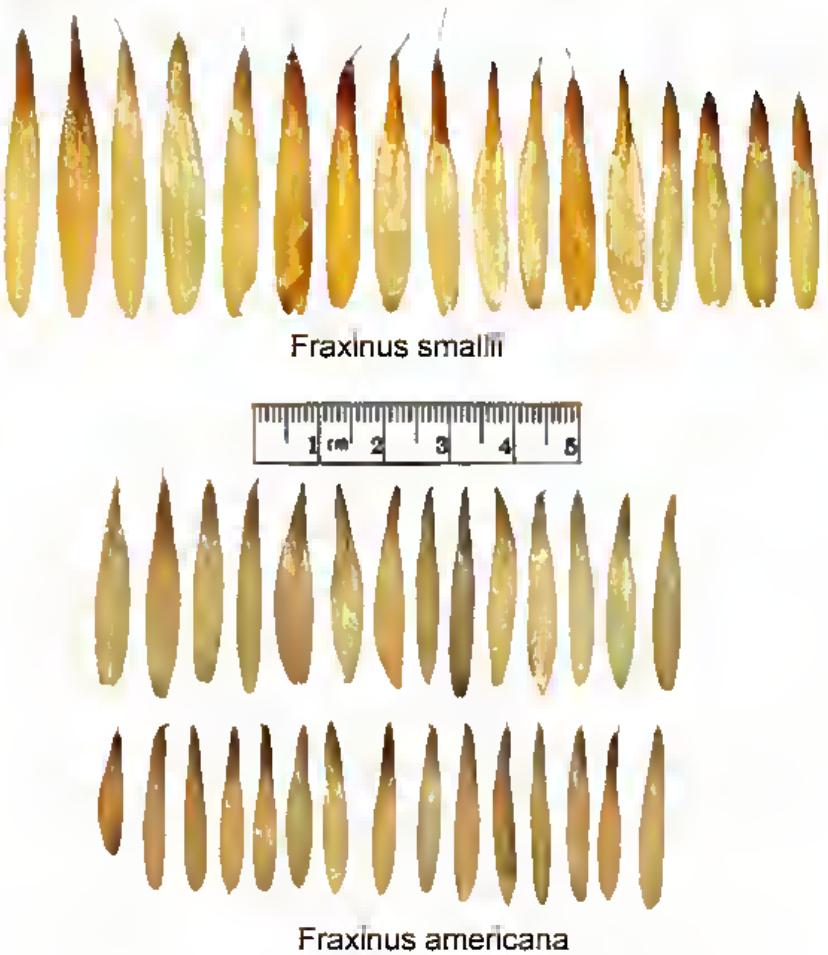

Figure 8 Samara variation in *Fraxinus smallii* and *F. americana*. Top row, *Fraxinus smallii* in Texas, Louisiana, and Arkansas. Size and shape are similar in other parts of the range. Bottom two rows, typical diploid white ash (*Fraxinus americana*) in Texas, Oklahoma, and Louisiana (same as from Fig. 7).

Figure 9. Samara variation in *Fraxinus biltmoreana* and *F. americana*. Top row, *Fraxinus biltmoreana* over its range. Bottom two rows, typical diploid white ash (*Fraxinus americana*) in Texas, Oklahoma, and Louisiana (same as from Fig. 7 and Fig. 8).

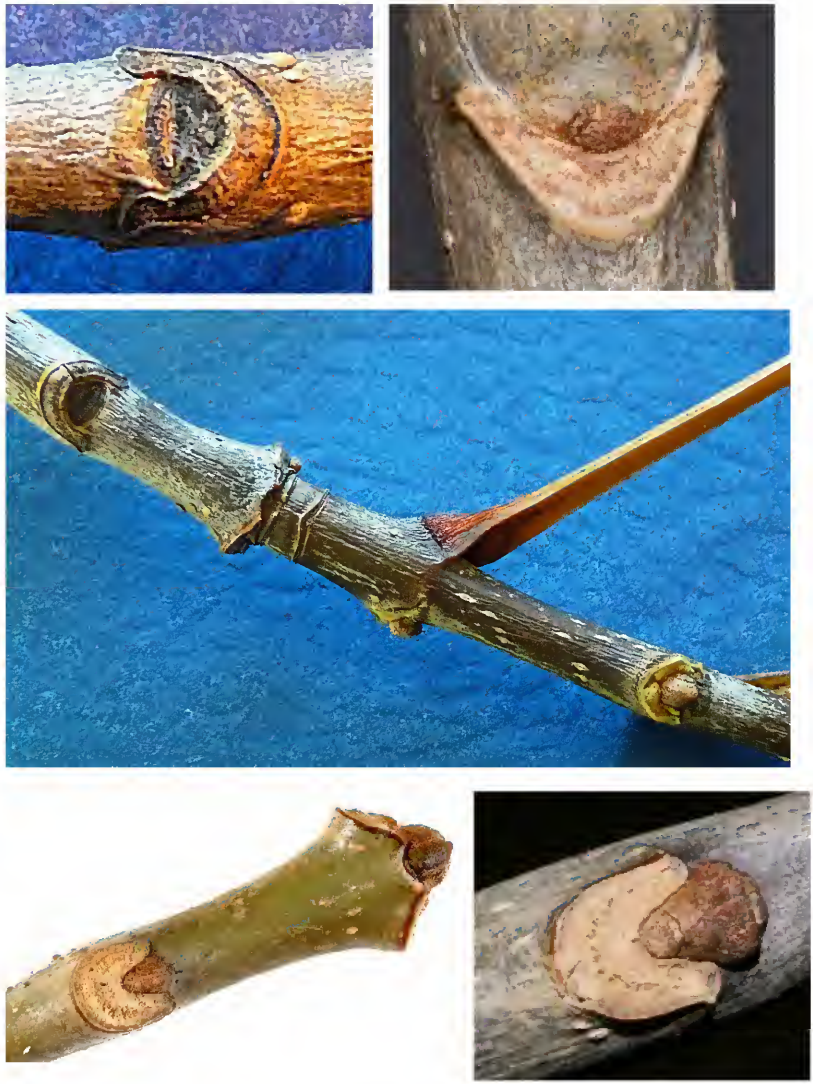

Figure 10. Leaf scar morphology: *Fraxinus americana*. Bottom left by B. Eugene Wofford, University of Tennesse Herbarium website, used with permission.

Figure 11. Leaf scar morphology: *Fraxinus smallii*.

Figure 12. Leaf scar morphology: *Fraxinus biltmoreana*.

Figure 13. Leaf scar morphology: *Fraxinus albicans*.

Figure 14. Leaf scar morphology: *Fraxinus pauciflora*.

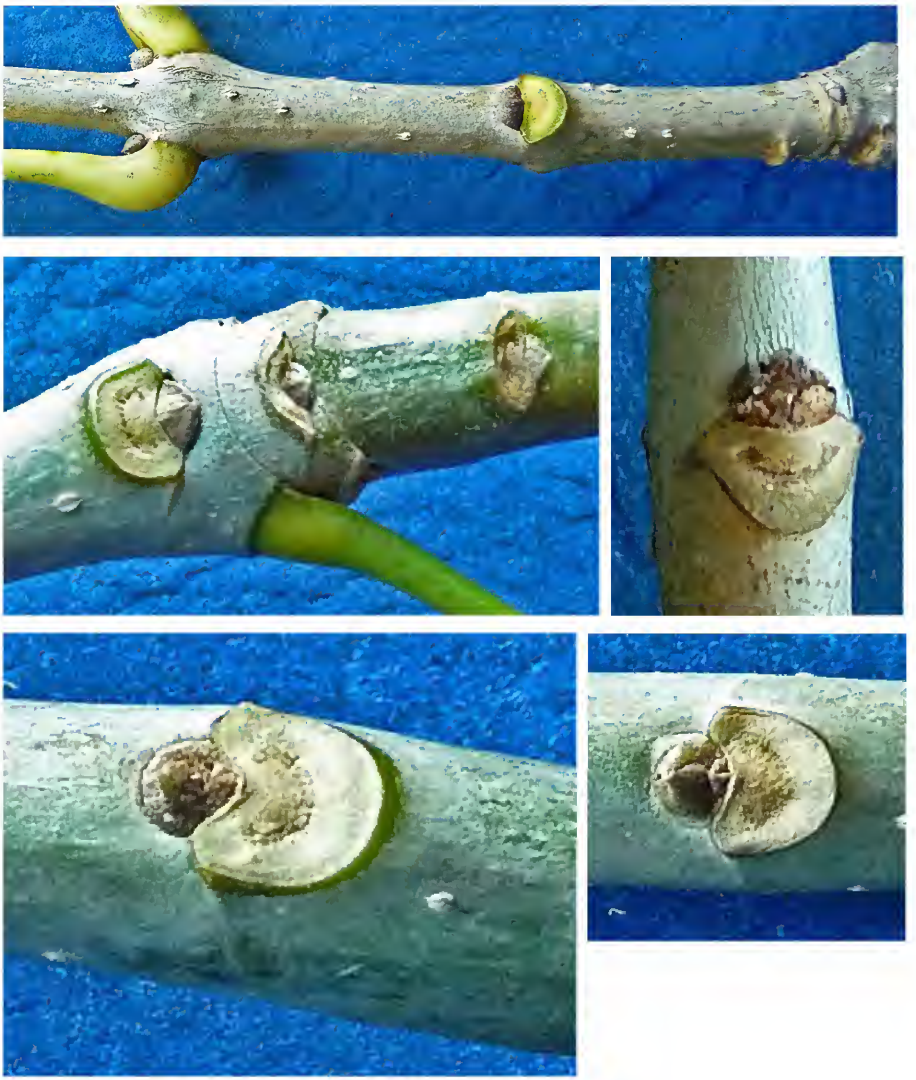

Figure 15. Leaf scar morphology: *Fraxinus pennsylvanica*.

Singhurst, J.R. and W.C. Holmes. 2010. Prenanthes aspera (Asteraceae: Cichorieae): New to Texas. Phytoneuron 2010-52: 1–4.

PRENANTHES ASPERA (ASTERACEAE: CICHORIEAE): NEW TO TEXAS

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ABSTRACT

Prenanthes aspera is reported as new to the native Texas flora — it has been discovered in a calcareous, open, pimple mound woodland and prairie in Bowie County. A key to the four species of *Prenanthes* occurring in the state and a distribution map are included.
KEY WORDS: *Prenanthes*, Asteraceae, Cichorieae, Texas.

On 8 May 2008, the authors discovered in Bowie Co., Texas, basal leaves of a plant that appeared to be an unknown (for the state) species of *Prenanthes*. It was not matched with any of the three known species because of differences in shape and/or distribution. The rootstock was collected and transplanted to the garden of the senior author in Austin. The plant flowered in 2010 and was identified as *P. aspera* Michaux, which is here reported as new to the state.

Specimen citation. **Texas**. [specimen grown in garden of J.R. Singhurst in Austin, Travis Co., collected 30 Sep 2010, *Singhurst 18337* (BAYLU); from a rootstock collected in] **Bowie Co**.: 0.9 mi. south of Dalby Springs, west side of US Hwy 59 at junction of FM 561; calcareous open pimple mound woodland and prairie with *Quercus stellata*, *Carya texana*, *Fraxinus americana*, *Schizachyrium scoparium*, *Liatris squarrulosa*, *Platanthera lacera*, *Helianthus mollis*, *Silphium integrifolium*, and *Rudbeckia triloba*; mesic woodland species on tops and bases of mounds with intermittent opening between mounds, 8 May 2008, *J.R. Singhurst and W.C. Holmes* (not numbered at time of collection).

Prenanthes aspera is a tallgrass prairie species that is known from the western Appalachian area, westward to the limits of the tallgrass prairies (Oklahoma, Kansas, Nebraska), south to Georgia and Texas (excluding Alabama) and north to South Dakota, Minnesota, Ohio, and Pennsylvania (Bogler 2006). Although mentioned as being in Louisiana by Small (1933), Cronquist (1980), and Bogler (2006), the location in that state is unknown (Gandhi & Thomas 1989; Thomas & Allen 1996). The species is rare or endangered in some states (Bogler 2006). In Texas, the species is best considered native and a rare peripheral species.

In 2004, Singhurst et al. published a taxonomic treatment of *Prenanthes* in Texas in which three species were reported, with *P. carrii* Singhurst, O'Kennon, and W.C. Holmes being proposed as new. Following is a key, adapted from that work, to the four species of *Prenanthes* currently known to occur in Texas.

KEY TO THE SPECIES OF *PRENANTHES* IN TEXAS

1. Capitula 5–6 flowered, involucres with 5 (–6) principal phyllaries, glabrous **Prenanthes altissima**
1. Capitula 10–15 flowered, involucres with 6–8 principal phyllaries, pubescent with long, coarse hairs.

2. Midstem leaves sessile to clasping **Prenanthes aspera**
2. Midstem leaves petiolate.

3. Lower and midstem leaves shallowly or deeply pinnately lobed, the upper lanceolate to oblong, petioles usually shorter than the blades, capitulescence racemose to slightly paniculate **Prenanthes barbata**
3. Lower and midstem leaves sagittiform, the upper ovate to triangular-deltate, petioles usually longer than the blades, capitulescence paniculate **Prenanthes carrii**

Figure 1 is a photograph of the species as it appeared in the garden at the time of collection. Figure 2 shows the county-level distribution of the genus by species within the state.

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Figure 1. *Prenanthes aspera* (*Singhurst 18337*, BAYLU), garden grown from collection in Bowie County. Photograph by Singhurst.

Figure 2. *Prenanthes aspera* (*Singhurst 18337*, BAYLU). Part of the photo in Figure 1.

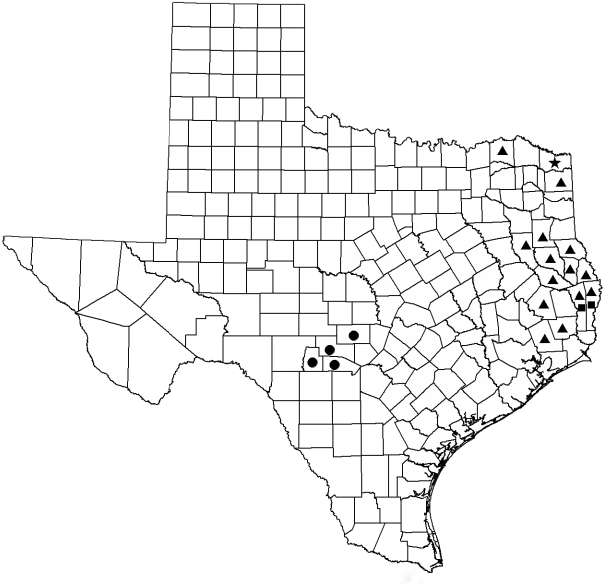

Figure 3. Distribution of *Prenanthes* in Texas. Filled circles *P. carrii*; triangles *P. barbata* (Torrey & A. Gray) Milstead ex Cronquist; squares *P. altissima* L.; and star *P. aspera*. Modified from Singhurst et al. (2004).

Mink, J.N., J.R. Singhurst, and W.C. Holmes 2010: *Dryopteris marginalis* (Dryopteridaceae): New to Texas. Phytoneuron 53: 1–6.

DRYOPTERIS MARGINALIS (DRYOPTERIDACEAE): NEW TO TEXAS

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ABSTRACT

Dryopteris marginalis (L.) A. Gray, the marginal wood fern, is reported as new to the native flora of Texas. The species is known only from Hemphill County, which is located in the southern Great Plains of the Panhandle area of the state. A voucher map of distribution of the fern in Texas and Oklahoma is included, along with a discussion of associated vegetation and notes on historical occurrence.

KEY WORDS: *Dryopteris*, Dryopteridaceae, Texas Panhandle, Canadian River, Hemphill County, Rolling Plains, Great Plains.

Until now, four species of *Dryopteris* (wood ferns) have been known to occur in Texas: *D. celsa* (W. Palmer) Knowlton (Diggs et. al. 2006), *D. cinnamomea* (Cav.) C. Christensen, *D. filix-mas* (L.) Schott, and *D. hudoviciana* (Kunze) Small (Turner et al. 2003). Recent botanical field investigations in the Panhandle region of Texas have resulted in the discovery of a fifth species, *Dryopteris marginalis* (L.) A. Gray, which we document here as new for the state.

Voucher: **TEXAS. Hemphill Co.**: Gene Howe Wildlife Management Area; along terraced stream bank adjacent to the Canadian river, 15 Oct 2009, *J.R. Singhurst 17614* (BAYLU). Figs. 2 and 3.

Dryopteris marginalis is the only known member of the genus in North America with sub-marginal/marginal sori (see Fig. 3). It can be readily distinguished from the other species of *Dryopteris* by the sori location and by the tawny scales on stipe and rachis. *Dryopteris filix-mas* and *D. celsa* may superficially resemble *D. marginalis* but both have serrate pinnae margins, whereas *D. marginalis* has entire pinnae or slightly lobed margins, not toothed. In *D. hudoviciana*, segments of fertile pinnae are distinctly narrower than sterile pinnae and occupy only the distal third to half of the blade. Lastly, *D. cinnamomea* has small laminae (14–26 cm length), stramineous to greenish (rarely castaneous) stipes with abundant long scales (8-18 mm) possessing entire margins, acuminate, twisted tips, and glandular adaxial and abaxial laminar surfaces. In Texas, *D. cinnamomea* is known only by a collection from ValVerde County near Comstock. The preceding paragraph of discriminating

characters is adapted from Lellinger (1985), Mickel & Beitel (1988), McVaugh (1992), and Montgomery and Wagner (1993).

Located on the eastern edge of the Texas Panhandle, the vegetation of Hemphill County is part of the mixed grass prairie of the Great Plains. In Texas, this area is known as the Rolling Plains vegetational region reflecting a natural plant community contingent on grassland development and diversification since at least the Miocene (Weaver 1954; Barnard & Frankel 1964). Nonetheless, the county includes many species that occur in similar riparian environments throughout the eastern United States. Characteristic eastern herbaceous species reported from Hemphill County are *Eupatorium perfoliatum*, *Euthamia gymnospermoides*, *Hibiscus laevis*, *Pluchea camphorata*, and *Thalictrum dasycarpum*. Notable eastern woody plants are *Cornus drummondii*, *Diospyros virginiana*, and *Morus rubra*, all infrequently occurring in the bottomlands of the Canadian River. Interesting or unusual species of the area are *Berula erecta* and *Verbena hastata*. The most abundant woody plants in Gene Howe Wildlife Management Area (GHWMA) bottomlands are *Ulmus americana*, *Celtis occidentalis*, and *Populus deltoides*, while *Quercus stellata*, *Sapindus saponaria* var. *drummondii*, and *Ulmus pumila* are principally limited to sloped and upland areas.

The western distributional limit of *Dryopteris marginalis* in the southern USA extends to central Oklahoma (McGregor & Barkley 1977, 1986; Montgomery & Wagner 1993). The known occurrence nearest to the Hemphill County record is in Comanche County, Oklahoma (Fig. 1), which is approximately 200 km to the southeast. The Canadian River, flowing west to east, bisects Hemphill County and portions of GHWMA. This river corridor is an important consideration, in concert with various influences of engineered or natural succession that contribute to landscape alterations. We postulate that these dynamics may have contributed to the distributional expansion of eastern herbaceous species such as *Dryopteris marginalis*.

Whether the occurrence of *Dryopteris marginalis* in Hemphill County resulted from eastern woodland encroachment or resulted from Pleistocene glaciations is unknown. It is plausible that environmental alterations, possibly by humans, contributed to the westward spread of the species. Over the last two centuries, anthropogenic influences have promoted westward expansion of more eastern riparian woodlands (Tomelleri 2004), especially throughout river corridors and associated mesic areas of the Great Plains (Johnson 1994). Extirpation of historic herbivore communities and subsequent replacement by domestic cattle pursuits are conspicuous examples of this influence. Repeated prairie fire suppression coupled with increased agricultural cultivation and continued introduction of alien species have also profoundly affected the natural regime and distributions of native plant species in the Great Plains.

The core of diversity for *Dryopteris* (Dryopteridaceae), a genus of about 250 species, is centered in temperate Asia (Wagner 1970; Montgomery & Wagner 1993; Smith 1993). Contemporary distributions of 14 known *Dryopteris* species in the USA and Canada (Montgomery & Wagner 1993) suggest a Pan-Tertiary migration, perhaps in combination with Pleistocene inter-glaciations. Peck and Peck (1988) discussed these taxa affinities, e.g. polyploidy and production of hybrids, and Pleistocene glaciation events that may have created conditions fostering diversification and current phytogeographic patterns of *Dryopteris* in North America.

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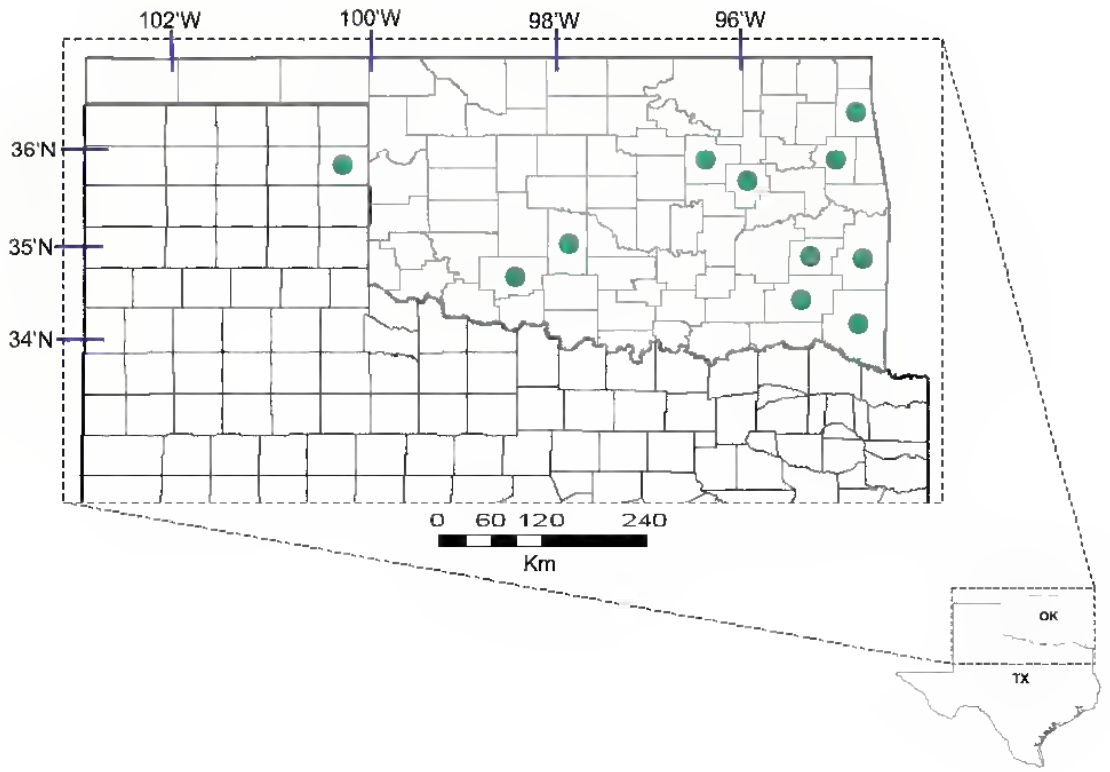

Figure 1. Known county distribution of *Dryopteris marginalis* in Oklahoma and Texas (from McGregor & Barkley 1977, 1986, Oklahoma Biological Survey 2010)

Figure 2. *Dryopteris marginalis*. Voucher, Hemphill Co., Texas (*Singhurst 17614*).

Figure 3a and b. *Dryopteris marginalis*. Voucher with mature submarginal sori, Hemphill Co., Texas (*Singhurst 17614*). The image below is from the upper one.

GLANDULARIA GOODDINGII (VERBENACEAE): NOTES ON DISTRIBUTION AND VARIATION

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ABSTRACT

The distribution of *Glandularia gooddingii* is mapped in detail in its USA range — California, Nevada, Utah, Arizona, and New Mexico. In New Mexico, it occurs in Hidalgo County, based on collections at UNM; records in other herbaria cited in literature for Bernalillo, Catron, DeBaca, Grant, Guadalupe, Lea, Luna, Otero, Sandoval, San Miguel, and Socorro counties, New Mexico, apparently are out of range for the species and are either known or presumed here to be some other species than *G. gooddingii*. Photos of representative plants illustrate the range in leaf variation, from coarsely toothed to bipinnately dissected.

KEY WORDS: *Glandularia gooddingii*, *Glandularia pubera*, distribution, USA

Glandularia gooddingii (Briq.) Solbrig is a distinctive species of the southwestern USA and adjacent Mexico, recognized by its coarsely toothed or incised to 3-lobed or bipinnatifid leaves, prominently stipitate-glandular stems and inflorescences, and large, showy corollas (pink to purple or lavender with broad limbs). It is known to be native in the USA in California, Nevada, Utah, Arizona, and New Mexico and in the Mexican states of Baja California, Baja California Sur, Sonora, and Sinaloa. The distribution of the species in the USA is shown in Fig. 1, the level of map detail mostly reflecting the large set of collections from ARIZ. The present report unequivocally documents its presence in New Mexico and notes previous misidentifications from that state.

Distribution in New Mexico.

Glandularia gooddingii was included in the New Mexico flora by Martin and Hutchins (1981) based only on a record from Dona Ana Co. Allred (2008) has based the entry for the species on the publication by Martin and Hutchins and on Umber (1979; but the attribution to Umber was mistaken, see below). All collections in the UNM herbarium, however, previously identified as *G. gooddingii* from New Mexico (Bernalillo, Grant, Otero, Sandoval, San Miguel, and Socorro counties) proved to be some other species. Apart from those putative UNM records, *G. gooddingi* has not been otherwise recorded from New Mexico by any of the herbaria in the SEINET consortium (SEINET 2010). A record from Lea Co., New Mexico, vouchered by a collection at Eastern New Mexico University in Portales (fide Kartesz 2010) is far out of range and surely is some other species.

Two collections, however, from extreme southwestern localities in New Mexico prove to be bona fide *Glandularia gooddingii*: **Hidalgo Co.**: [Peloncillo Mts.,] Guadalupe Canyon, canyon bottom, near sycamores and mesquite, 4000 ft, 27 Oct 1957, *Harris 44* (UNM); Peloncillo Mts., ca. 6600 ft, 22 Feb 1975, *Wagner 531* (UNM).

Umber (1979, Fig. 9) did not cite or map *Glandularia gooddingii* from New Mexico. He mapped it in southeastern Arizona only from Cochise Co., including the Chiricahua Mountains, immediately adjacent to Hidalgo Co., New Mexico. I have not seen a collection of *G. gooddingii* from other far-eastern Arizona counties (Apache, Greenlee), leaving Cochise County as the easternmost known locality for the species in Arizona (Fig. 1).

Moldenke (1963) reported *Glandularia gooddingii* from an unknown New Mexico county (*Rusby 337*, MICH) and explicitly from four counties: Catron Co.: *Goddard 825* (UC); Grant Co.: *Ballou s.n.* (DS), *Maguire et al. 11503* (NY), and *Mohr s.n.* (US); Otero Co.: *Cutler 2002* (UC); and DeBaca Co.: *Nelson 11307* (S). He later noted (1980), without documentation, that the species occurs in seven New Mexico counties: Catron, DeBaca, Grant, Guadalupe, Luna, Otero, and Sandoval. Most of these are clearly out of range for *G. gooddingii* and are either known or presumed to be some other species.

It is not implausible that *Glandularia gooddingii* occurs in Catron and Grant counties, but I have not seen any of the cited vouchers from there. The abundancy of inconsistent identifications of many *Glandularia* collections, however, and the apparent absence of *G. gooddingii* in far-eastern Arizona counties (except for Cochise Co.) at least suggest that the Catron and Grant collections also may be misidentified.

Distribution elsewhere.

Records included in Fig. 1 for Utah counties are from the Digital Atlas of the Vascular Plants of Utah (Ramsey et al. 2010). The record for Lincoln Co., Nevada is cited by Moldenke (1963): Calientes, 29 Apr 1904, *M.E. Jones s.n.* (POM). The type of *Glandularia gooddingii* apparently is from Clark County, close to the Lincoln County line.

A historical record exists for *Glandularia gooddingii* in San Diego Co., California, as cited by Perry (1933): "southern part of San Diego Co., 1875, *Palmer s.n.* (GH). Rebman and Simpson (2006) included the species in the appendix as reported for San Diego County but unvouchered/ unsubstantiated — this record derived from Beauchamp (1986), who noted that it is rare in San Diego County and known only from a vague locality in the Santa Rosa Mountains (perhaps alluding to the Palmer collection?). The probability of the occurrence in San Diego County is substantiated by the distribution of the species in Baja California, where it is documented from within about four kilometers south of the California border, from there south to the Sierra San Francisco of northern Baja California Sur (as mapped from specimens from multiple herbaria, fide BajaFlora 2010).

References to the presence of *Glandularia gooddingii* in Alabama, Colorado, Oklahoma, and Texas (Moldenke 1963, 1980) apparently have been based either on misidentifications or cultivated plants, as the species has not been documented in any recent floristic summaries for those states and I have seen no evidence of their existence there. The tentative report for Colorado by Harrington (1954) has been persistent and repeated in various other literature, but presence there of *G. gooddingii* has not been substantiated (Weber & Wittmann 1992, 2000; Hartman & Nelson 2001). Harrington's Colorado record presumably was based on a citation by Perry (1933): "southern Colorado, 1867, *Parry* (US)." Moldenke (1963) cited "*C.C. Parry 551*, in part" (US) from an undetermined Colorado locality.

Nomenclature.

Verbena gooddingii var. *nepetifolia* Tidestrom (the type from Clark Co., Nevada: El Dorado Cañon, 2 Apr 1919, *I. Tidestrom 8835* (holotype: US digital image!) has sometimes been recognized as a distinct taxon but now is considered, here and generally elsewhere, to be synonymous with the typical expression of the species (the type from Clark Co., Nevada: Kernan, Meadow Valley Wash, 28 Apr 1902, *L.N. Goodding 645* (isotypes: F digital image!, GH, US digital image!). *Glandularia wrightii* var. *intermedia* Moldenke (the type from Pima Co., Arizona, holotype: NY digital image!) also is a synonym of *V. gooddingii*. Other synonyms are *G. gooddingii* var. *intermedia* Moldenke, (type from Pima Co., Arizona), *Verbena verna* A. Nelson (type from Mohave Co., Arizona), *Verbena verna* var. *fissa* A. Nelson (type from San Bernadino Co., California), and *Verbena arizonica* Briq. (type from Mohave Co., Arizona).

Variation in leaf morphology.

Leaves in *Glandularia goodding*ii vary from coarsely toothed or lobed to incised, 3-lobed, or bipinnately divided — the range of variation is shown in Figs. 2-6. Those with merely toothed to shallowly lobed or incised leaves are distinctive and rarely if ever misidentified. Those with deeply dissected leaves may resemble plants of the *G. bipinnatifida* group, especially in Arizona where they are sympatric. In fact, evidence suggests that *G. goodding*ii may be closely related to *G. pubera* (Green) Nesom, which has bipinnatifid leaves with linear segments (see Nesom 2010 for a description of *G. goodding*ii and a key couplet that separates it from *G. pubera*). Both species have short floral bracts, densely stipitate-glandular calyces, short calyx lobes, and broad corolla limbs (10–14 mm in diam.). Some plants of *G. goodding*ii, especially among those with dissected leaves, have bright pink corollas similar in color to those of *G. pubera*.

Plants of *Glandularia goodding*ii with dissected leaves are mostly in the northeast portion of the range of the species, as shown in Fig. 1. The 'nepetifolia' morphology, with coarsely toothed leaves, is characteristic of most of the Mexican plants. There appears to be too much intergradation to maintain a formal taxonomic distinction, but the difference is worth further study, especially in view of the two ploidy levels reported for the species — tetraploid from Coconino Co., hexaploid from Baja California (summary in Umber 1979).

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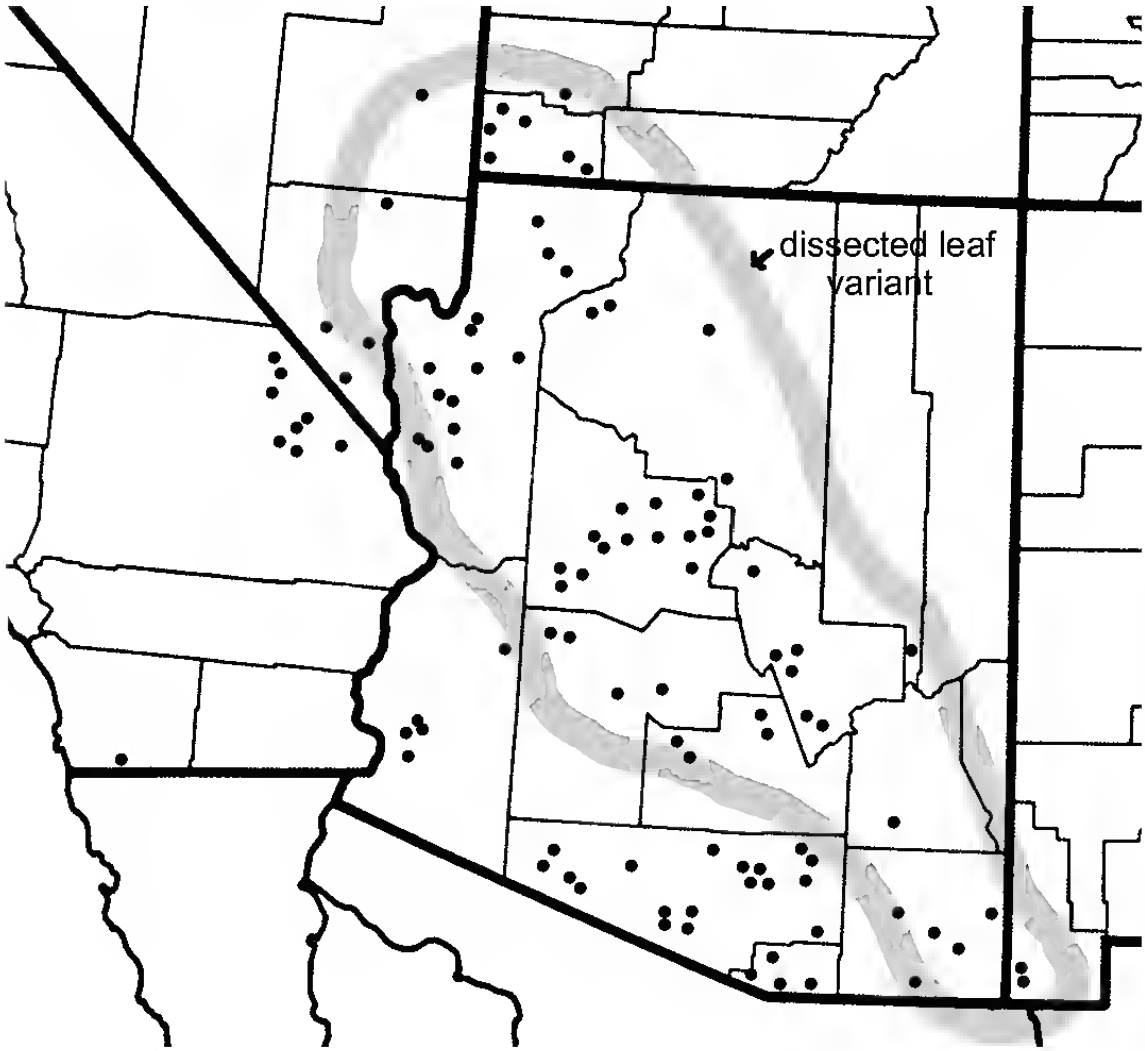

Figure 1. Distribution of *Glandularia gooddingii* in the USA. The distribution continues into Mexico, south into Sonora and Sinaloa and west into Baja California. Records are based on collections from ARIZ, TEX-LL, and UNM and from other sources as noted in the text. The record for southern San Diego County, California, is discussed in the text. Variants with dissected leaves are mostly within the area bounded by the shaded line (see text for comments).

Figure 2. *Glandularia gooddingii*, leaves coarsely toothed

Figure 3. *Glandularia gooddingii*, leaves coarsely toothed to incised

Figure 4. *Glandularia gooddingii*, leaves coarsely toothed to moderately dissected

Figure 5. *Glandularia gooddingii*, leaves dissected.

Figure 6. *Glandularia gooddingii*, leaves strongly dissected, bipinnatifid.

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LIRIOPE AND *OPHIOPOGON* (RUSCACEAE) NATURALIZED IN ALABAMA

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ABSTRACT

Liriope muscari, *L. spicata*, and *Ophiopogon japonicus* are documented as naturalized in Alabama, where they occur on wooded slopes, in floodplains and riparian habitats, and in disturbed sites. The occurrences of *O. japonicus* are the only known instances of naturalization of that species in the USA. Each species is documented by photos of one or more vouchers.
KEY WORDS: *Liriope*, *Ophiopogon*, naturalized, Alabama

Published documentation for the naturalization of *Liriope* and *Ophiopogon* in the USA is essentially lacking, although species of both genera are reported to grow outside of cultivation (e.g., Kartesz 2010; USDA, NRCS 2010). To accompany an overview of these genera as cultivated and naturalized in the USA (Nesom 2010), collections of plants naturalized in Alabama are here placed on record. Specimens are from ANNISTON, JSU, and VDB.

Many of the Alabama sites with naturalized *Liriope* ("monkey grass") and *Ophiopogon* ("mondo grass") are wooded slopes with residential or commercial development above. Habitats of naturalized plants are mostly undisturbed along the Cahaba River in Jefferson and Shelby counties (in the middle of Birmingham), along Black Creek at Noccalula Falls (downstream from the park where they were grown in the garden area) in Etowah County, and along the Tennessee River with residential development above in the town of Sheffield in Colbert County. Naturalized habitats where disturbance is typically minimal include floodplains and riparian sites. Collectively, however, the liriopogons also may occur in historically disturbed areas, cemetaries, or old homesites like those cited below from Dallas County.

Both genera are commonly used in landscapes in our area as a border-grass. As escapes they often have the appearance of an upland *Carex*, except that they usually occur in large clumps, and these plants are not represented well in herbaria because they are probably often overlooked. Each of the species documented here can be expected to become more common in nature — they spread by

asexual fragmentation of the stoloniferous clones and the fruits easily wash away from source populations to establish new ones.

OPHIOPOGON JAPONICUS (Thunb.) Ker-Gawl.

Alabama. **Colbert Co.**: rich woods on N-facing ravine (Cliff Haven) with exposed Tuscumbia Limestone and Fort Payne Chert, adjacent to the Tennessee River (Pickwick Lake) across from McFarland Park in Sheffield; slope scattered with clusters of this exotic along with *Liriope muscari*, most likely spread from development above the ravine, 17 Apr 2006, *Spaulding 12410* (ANNISTON-Fig. 1). **Dallas Co.**: Old Cahawba FW Tract, SW of Selma, near old pecan orchard in historic black cemetary, near N32.32534 W87.09684, 20 Oct 2010, *Barger and Holt OC-95* (ANNISTON-Fig. 2).

LIRIOPE MUSCARI (Dcne.) Bailey

Alabama. **Calhoun Co.**: Coldwater, jct US Hwy 78 and Coldwater Ck, floodplain, 30 Jul 1986, *Lawler 890-Whetstone 15462* (JSU-Fig. 4). **Clay Co.**: forested floodplain area adjacent to campgrounds at Lake Chinnabee Recreation Area, 18 Mar 1995, *Spaulding 8908* (JSU). **Coffee Co.**: vic. of Kingston, along Hwy 474 (Hwy 6 on old map) at 0.1-0.3 mi W of jct with Pea River, local colony on S side of road ca. 0.1 mi W of bridge in small patch of trees by dirt road, 2 Jan 1999, *McDonald 12521* (VDB). **Colbert Co.**: rich woods on N-facing ravine (Cliff Haven) with exposed Tuscumbia Limestone and Fort Payne Chert, adjacent to the Tennessee River (Pickwick Lake) across from McFarland Park in Sheffield; slope scattered with clusters of this exotic along with *Ophiopogon japonicus*, most likely spread from development above the ravine, 17 Apr 2006, *Spaulding 12404* (ANNISTON-Fig 3). **Etowah Co.**: rocky sandstone woods along Black Creek along Noccalula Falls on Lookout Mountain in Gadsden, 6 Aug 1994, *Hodge 2967-Spaulding 7095* (JSU); Gadsden, rocky slope near Paseur Park on Lookout Mountain at jct of Bellevue Drive and Highland Ave., 7 May 1995, *Hodge 4218-Spaulding 7957* (JSU). **Henry Co.**: woods along Chattahoochee River W from Ft. Gaines, Ga.; one large clump just NW of boat launch area, 26 Mar 1999, *McDonald 12605* (VDB). **Houston Co.**: Dothan (NW side of town), along Murphy Mill Rd at jct with Murphy Mill Creek Bridge, on bank near bridge, 22 Jun 1991, *McDonald 2632* (VDB). **Jefferson Co.**: secondary woods in NE Birmingham along Village Creek, Birmingham-Big Canoe Valley district of the Ridge & Valley province, 11 Jun 2000, *Spaulding 10,882* (JSU).

LIRIOPE SPICATA Lour.

Alabama. **Baldwin Co.**: Co. Hwy 47, 0.1 mi E of Interstate Hwy 65, hardwood area with thick understory of *Ligustrum sinense*, 25 May 2002, *Diamond 13220* (ANNISTON-Fig. 5, VDB). **Dallas Co.**: Old Cahawba FW Tract, SW of Selma, near N32.32534 W87.09684, in field leading through old pecan orchard by historic black cemetary, 15 Apr 2010, *Barger and Holt OC-130* (ANNISTON-Figs. 6 and 7), 20 Oct 2010, *Barger and Holt 130a* (ANNISTON), and 20 Oct 2010, *Barger and Holt OC-130b* (ANNISTON); Selma, E of US Hwy 80 along N side of the Alabama River, old warehouse district along the river, 12 Jul 2004, *Diamond 14493* (VDB). **Shelby Co.**: Cahaba River at Co-29, escaped from cultivation but well established, 28 Jul 1977, *Sessler 1772* (VDB); alluvial woods along the Cahaba River, SE of Birmingham, 11 Oct 1997, *Spaulding 10,134* (JSU, VDB).

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Figure 1 *Ophiopogon japonicus* naturalized in Colbert County

Figure 2. *Ophiopogon japonicus* naturalized in Dallas County.

Figure 3. *Liriope muscari* naturalized in Colbert County

Figure 4. *Liriope muscari* naturalized in Calhoun County.

Figure 5. *Liriope spicata* naturalized in Baldwin County.

Figure 6 *Liriope spicata* naturalized in Dallas County.

Figure 7. *Liriope spicata* naturalized in Dallas County.

Figures 8a and 8b. *Ophiopogon japonicus* in Dallas County, population vouchered by *Barger and Holt OC-95*, 10 Oct 2010. Photos by Wayne Barger.

Nesom, G.L. 2010. Overview of *Liriope* and *Ophiopogon* (Ruscaceae) naturalized and commonly cultivated in the USA. Phytoneuron 2010-56: 1–31.

OVERVIEW OF *LIRIOPE* AND *OPHIOPOGON* (RUSCACEAE) NATURALIZED AND COMMONLY CULTIVATED IN THE USA

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ABSTRACT

The Asian natives *Liriope spicata*, *L. muscari*, *Ophiopogon jaburan*, and *O. japonicus* have been reported to be naturalized at various localities in the USA; reports of *O. jaburan* have been based on misidentifications. The naturalized occurrence of two *Liriope* species in Texas is documented here: (1) *L. spicata* occurs abundantly in large colonies along a forested creek within a city park in Fort Worth (Tarrant Co.) and it has been collected from a bottomland hardwood forest in the Big Thicket National Preserve; (2) a large plant of *L. graminifolia* is growing in low woods in a city park in Euless (Tarrant Co.). A key, brief descriptions, and basic synonymy are provided for the naturalized species as well as for *L. gigantea*, *O. intermedius*, *O. jaburan*, and *O. planiscapus*, which also are sold and commonly cultivated in the USA. An **Online Appendix** provides representative photos of the species in cultivation and in naturalized habitats. *Liriope gigantea* sensu stricto (colonial from stolons) differs in habit from the species now generally sold as *L. gigantea* (caespitose) — no species identified as *L. gigantea* has been recognized to occur natively in Asia. The name *Liriope exiliflora* is treated as a synonym of *L. muscari*; plants abundantly cultivated in the USA and often identified as *L. exiliflora* are instead *L. graminifolia*.

KEY WORDS: *Liriope*, *Ophiopogon*, cultivars, Ruscaceae, Liliaceae, naturalized, Texas, USA

Species of *Liriope* Lour. and *Ophiopogon* Ker Gawl. are commonly and abundantly planted in the southeastern and southcentral USA in various ways in landscapes, particularly as ground cover and border plants. All are characterized by basally tufted, linear, evergreen leaves and often are known as "lilyturf," "mondo grass," "Aztec grass," or "border grass," or sometimes as "monkey grass." At least one of them has been called "table grass," alluding to its graceful appearance in a pot placed on a table or desk. As a group, species of both genera are sometimes referred to as "liriopogons," a termed introduced by Skinner (1971), generally supplanting the earlier "liriomondos" suggested by Bailey (1929).

Four species of liriopogons have been reported as naturalized in the USA: *Liriope muscari* (Dcne.) L.H. Bailey, *L. spicata* Lour., *Ophiopogon jaburan* (Sieb.) Lodd., and *O. japonicus* (Thunb.) Ker Gawl. (USDA, NRCS 2010; Kartesz 2010). *Liriope graminifolia* (L.) Baker is added to this list in the current report and *O. jaburan* is removed, as reports of the latter have been based on misidentifications. Of these species, apparently only *O. japonicus* has been reported to grow outside of cultivation anywhere else in the world — from one locality in Brazil (GCW 2010; Instituto Hórus 2010). For the treatment of Liliaceae in Flora of North America North of Mexico (FNANM), Utech (2002) noted that *Liriope muscari*, *L. spicata*, and *Ophiopogon jaburan* "have been reported as escaped in the flora … but "are not clearly naturalized" and he did not provide a treatment for either of the genera.

In addition to the species reported as naturalized in the USA, the present account includes *Liriope gigantea* H. Hume, *Ophiopogon intermedius* D. Don, and *O. planiscapus* Nakai, which also are sold and cultivated in the southeastern USA. An overview by Hume (1961) of liriopogons cultivated in the USA included *O.* "*arabicus*" as distinct, but this is a horticultural name for a cultivar

of *O. planiscapus*. Hume and Morrison (1967) included *O. jaburan*, *O. japonicus*, *O. planiscapus*, *L. exiliflora* (here regarded as a synonym of *L. muscari*), *L. gigantea*, *L. graminifolia* (tenuously distinguished by Hume and Morrison from *L. exiliflora*), *L. muscari*, and *L. spicata* in their account of commonly cultivated lilyturfs. Broussard (2007) studied 19 cultivars of *Liriope* and *Ophiopogon* and identified seven species among them — all of them are included in the present manuscript. A brief note on the remaining three or four species of *Liriope*, to complete the genus, also is included.

Fantz (1993) observed that "names of available liriopogons cultivated in the United States based on literature and catalogues [total] more than 20 named species and more than 100 named cultivars, even after elimination of similar names" — he listed 26 species. In a follow-up publication (Fantz 1994), he listed 22 species and 88 cultivars and noted (Fantz 1995) that "a minimum of fourteen morphologically defined species are in cultivation in the United States" — 6 of *Liriope* and 8 of *Ophiopogon*. In his last two most recent publications, Fantz has provided a key and descriptions for 6 species of *Liriope* (2008b) and for 14 of *Ophiopogon* (2009), documenting all as cultivated in the southeastern USA or at least for sale in the regional horticultural trade. Fantz's studies (at North Carolina State University in Raleigh) were supported by observations on plants of many or most of the species and horticultural forms that he cultivated over 15 years.

Species of *Liriope* and *Ophiopogon* are native to southeastern Asia and the most comprehensive accounts of both genera are in the Flora of China (Chen & Tamura 2000a, 2000b) and the Flora of Japan (Tamura in press). Studies of species groups have been published by Hasegawa (1968), Hara (1984), Tamura (1990), Yang and Li (1990a, 1990b), Yamashita and Tamura (2001), and Tanaka (1998–2000, 2001). Except for the recent reports by Fantz, most accounts of liriopogons in the USA have included only a few species (e.g., Bailey Hortorium Staff 1976; Walters et al. 1984; Adams 1989; Deputy 1999). Regarding potentially naturalized species, beyond a specimen citation or simply the inclusion of the listed name in a floristic account, there appears to be little or no commentary on any of these in North American taxonomic literature.

The present report documents Texas occurrences of *Liriope spicata* and *L. graminifolia* outside of cultivation and provides a taxonomic and photographic overview of commonly cultivated liriopogon species in order to provide a readily available source for their identification in the USA. A detailed account of liriopogons naturalized in Alabama is provided by Spaulding et al. (2010). For critical studies, botanists should have primary Asian literature, especially from the Flora of China and the Flora of Japan, and the recent assessments by Fantz. The treatment here of *Liriope* is parallel to that of Fantz (2008b) except for the name of one species, but Fantz (2009) has treated 14 cultivated species of *Ophiopogon* compared to the four included here. The article by Hume and Morrison (1967) also is useful for its descriptions of common cultivars.

Methods.

For the present review, I have seen many plantings of *Liriope gigantea*, *L. graminifolia*, *L. muscari*, *L. spicata*, *Ophiopogon japonicus*, *O. intermedius*, and *O. planiscapus*. The account here of *O. jaburan* is from published sources. Unless otherwise specified, state records given here for putatively naturalized populations are from summaries by Kartesz (2010) and the PLANTS Database (USDA, NRCS 2010).

Using various sources (literature, internet, nurseries), I have attempted to align names of common cultivars with species, but this should be taken only as a best approximation. Some cultivar names apparently have been duplicated (e.g., a "Variegata" has been developed in more than one species) and inconsistencies are widespread in identification of species and cultivars (see details and examples by Fantz 1993, 1994), even as distributed by growers. Even patent applications for new cultivars are apparently not required to document the parentage (e.g., see applications shown at

internet sites "PatentStorm," "PatentGenius," "FreePatentsOnline," etc. — or search the US Patent Office Collection <http //patft uspto gov/netahtml/PTO/search-adv htm>).

Synonymies of scientific names are derived from primary literature and floristic treatments of Chinese and Japanese species (as cited below). The provenance is indicated for types of all of the names included here and I have examined types where photographs or digital images are available (as indicated in the typification summaries; images via website of individual herbaria and JSTOR). Hi-res images of the holotype of *Convallaria spicata* Thunb. were made available by staff at UPS and those photos are included in the manuscript as Figures 1 and 2.

A set of photos taken mostly by the author is included in the present report (see **Online Appendix**). Photos identified by cultivar name can be found on a number of commercial internet sites, e.g., "acemondo.co.nz," "davesgarden.com," "gogardennow," "groundcovertogo.com," and "liriope.com." A good site for a diversity of high-quality photos of *Liriope* and *Ophiopogon*, with interesting notes by J.C. Raulston, is at <www.cultivar.org>. The dissertation by Broussard (2007; online) also has a series of good photos of cultivars in situ and of representative herbarium specimens.

***Liriope* and *Ophiopogon* at generic rank.**

Liriope includes about eight species distributed in Pakistan, China (including Taiwan), Korea, and Japan to Indochina (Vietnam, Laos, Cambodia) and the Philippines. *Ophiopogon* includes about 54 species (fide Conran & Tamura 1998) or 65 species (fide Chen & Tamura 2000b) in essentially the same area as *Liriope* but definitely known from other Himalayan countries and most of Indochina (see distribution of *O. intermedius*, below) as well as Malesia. The two genera are closely related and vegetatively similar — the most significant differences are in floral morphology (see key below). Both are now placed in the Ruscaceae (Rudall et al. 2000; Nyffeler & Eggli 2010).

A dendrogram of 18 popular cultivars studied by Mcharo et al. (2003) — based on AFLP markers — diverges somewhat from expected groupings according to the putative name assignments here, which lead the authors to suspect that *Liriope* and *Ophiopogon* might be conspecific. Differences in floral morphology, however, appear to be consistent and floristic treatments and other Asian studies have not found placement of species to genus problematic.

The genera *Liriope*, *Ophiopogon*, and *Peliosanthes* Andrews (ca. 11 species, south China to Indochina, Malesia, and India; or 1 species, fide Jessop 1976; also see Yamashita et al. 2002) have been considered to comprise the tribe *Ophiopogoneae* Endl. (e.g., Cutler 1992; Conran & Tamura 1998) or even a separate family, the Ophiopogonaceae Meisn. (Conran 1989), defined by tufted clusters of grasslike leaves, a spikelike inflorescence, irregularly and early dehiscent, 1-seeded fruits, and sarcotestal seeds. It is clear that *Liriope* and *Ophiopogon* are sister taxa, but the relationship of *Peliosanthes* has been shown to lie elsewhere (Rudall et al. 2000), reducing the Ophiopogoneae to only the two genera.

Notes on species biology.

a. Chromosome number.

At least some of the widespread species of *Liriope* and *Ophiopogon* are variable in ploidy level (e.g., see *L. graminifolia*, *L. muscari*, *L. spicata*, *O. intermedius*, *O. japonicus*; chromosome number summaries at the end of morphological descriptions are from Zhang 1998). This at least suggests that the morphological variation may be partitioned to a greater extent than currently recognized. If alloploidy has been involved in the formation of supra-diploid levels, attempts to understand relationships among species may be minimally meaningful without a detailed knowledge of genomic constitution of the plants under investigation. Chromosome number variation appears to

have originated in natural populations; I have not encountered any discussion or indication of hybridization involved in the production of cultivars.

Fukai et al. (2008) estimated ploidy levels (using flow cytometry) of cultivars they identified among six species of *Liriope* and *Ophiopogon*: *L. minor* (2x), *L. spicata* (6x), *O. jaburan* (2x), *O. japonicus* (4x), *O. planiscapus* (2x), and *O. platyphylla* (4x). Apart from this report, I have not encountered information regarding ploidy levels of cultivars.

b. Flowers.

The occurrence of inferior to semi-inferior ovaries in *Ophiopogon* is viewed by Rudall (2002) as one among numerous multiple and independent origins of epigyny within monocots in general and Asparagales in particular, probably linked with the evolution of different pollination syndromes. As in *Liriope*, flowers of most taxa of Asparagales are hypogynous, the primitive condition; the predominantly epigynous to perigynous flowers of *Ophiopogon* are specialized. Zhang (1998) has noted, however, that the position of the ovary is variable in both *Liriope* and *Ophiopogon*, sometimes even within a single species, and thus is not a consistently diagnostic feature.

Pedicels of these plants in early development are similar in color and texture to the corolla and floral tube (in *Ophiopogon*) and corolla (in *Liriope*). In *Liriope*, where a floral tube is essentially absent, the "pedicel" has been described in some literature as articulated distally, i.e, directly beneath the corolla. In *Ophiopogon*, the "pedicel" has been described as articulated medially, indicating the point of division between the slender floral tube (the "perigone," fide Fantz 2008a), and the actual pedicel. During fruit development or after abscission of the corolla, the persistent pedicel in both genera becomes more clearly differentiated, appearing stramineous and somewhat sclerified. At least in *O. jaburan* and *O. japonicus*, and presumably other species of *Ophiopogon* with semi-inferior ovaries, the pedicel and perigone may remain connected and persistent as a unit subtending the fruit until after it is released.

In some of cultivars of *Liriope*, flowers apparently never open and eventually are deciduous still in the form of buds. Hume and Morrison (1967) specifically noted that this is true of *L. muscari* "Christmas Tree." The observation by Hume (1961) and Hume and Morrison (1967) — and corroborated here at least for some cultivars of *L. muscari* and *L. graminifolia* — that the sequence of flower development is irregular over the inflorescence was questioned by Zhang (1998), who noted that opening of flowers is generally acropetal. An acropetal sequence can be seen in some young inflorescences (see photos of *L. muscari* in the Online Appendix).

c. Stolons and roots.

Some of the species in the present account reproduce clonally by shallow, laterally spreading stolons. These are slender and whitish underground stems with narrowly triangular scale leaves at the relatively widely spaced nodes, usually unbranched, sometimes producing adventitious roots, and producing a new leafy plant at each stolon apex. One or more stolons may be produced from a single leafy plant. Fantz (2008a) termed these structures rhizomes, restricting the use of stolon to creeping, above-ground stems. In the liriopogons, these might be termed stolon-like rhizomes, but they are closest to what are generally identified as stolons in plants over a wide range of taxonomically diverse species (see excellent summary and discussion of stolons and rhizomes in Wikipedia). Stolons and rhizomes are not completely dichotomous in distinction, and the term rhizome might be appropriately applied to very short stolons sometimes produced in *Liriope muscari* (see comments below). Representative stolons are shown in the Online Appendix.

Elongating stolons usually are not formed in *Liriope muscari* and *Ophiopogon jaburan*, which are "caespitose" forms that increase and slowly spread by production of new shoots from

lateral buds in the caudex crown. Hume and Morrison (1967) noted that "an old clump of *L. muscari* eighteen inches in diameter may give as many as one hundred and fifty separate pieces" ("bibs," daughter plants with few leaves, fide Fantz 2008a), presumably from crown buds, but the manner of reproduction was not specified.

Some forms of cultivated *Liriope muscari*, however, do produce short stolons (see comments below under *L. muscari* and photos in the Online Appendix), and stolon production also appears to be variable in *L. gigantea* (see comments under *L. gigantea*). The same may be true in other primarily caespitose, "clumping" species (e.g., perhaps cultivars of *Ophiopogon intermedius*). Fantz (2008a, p. 335) noted that "weakly rhizomatous plants" [of liriopogons] have short stolons, "with daughter plants borne close to the mother plant and their roots intertwining. This growth pattern will form a dense carpet or mound over the ground with age, with original planting sites merging together, providing an attractive ornamental appearance."

Liriopogons are generally described as "clumping" or "spreading" in horticultural information but below-ground parts are almost never described. Unequivocally "spreading" or "colonial" forms, which sometimes are also termed "invasive," are *L. spicata*, *L. graminifolia*, and *Ophiopogon japonicus*. Caespitose or primarily caespitose forms are used for borders and for plantings where a certain persistent geometry is desired.

Most of the liriopogon species in cultivation in the USA produce tuber-like ellipsoid swellings, sometimes in tandem, usually at or near the distal ends of the fibrous root system (photos in Online Appendix). Steroidal saponins, steroidal glycosides, and sesquiterpene glycosides have been isolated from tuberous swellings of *Liriope muscari*, *L. spicata*, *O. japonicus*, and others (e.g., Ahmad & Basha 2006; Cheng et al. 2004, 2006; Yu et al. 1996). The root "tubers" of *L. spicata* are used medicinally in China and the species is widely cultivated there for that reason. These organs have not been observed to have a reproductive function.

KEY TO THE COMMONLY CULTIVATED SPECIES

1. Flowers erect, terminal at the tip of a strict pedicel, corollas cupulate to rotate; ovaries superior (flowers hypogynous); anthers free, oblong in outline, apically obtuse, dehiscing apically and appearing poricidal, filaments longer than or as long as anthers; stigmas entire; fruits blackish ..... **LIRIOPE**

2. Plants caespitose, without stolons or weakly stoloniferous or rhizomatous; leaves (5–)8–16(–23) mm wide, (15–)30–70 cm long.

3. Leaves mostly 24–55 cm long, relatively thin, flexuous and arching 45° to 140° or more; scapes usually equal or longer than the leaves, sometimes shorter ..... 1. **Liriope muscari**
3. Leaves mostly 50–80 cm long, relatively thick, usually relatively stiff, slightly arching 45° to 90°; scapes usually distinctly shorter than the leaves ..... 3. **Liriope gigantea**

2. Plants colonial, from slender stolons; leaves (2–)3–8(–10) mm wide, (14–)18–60 cm long.

4. Scapes (15–)20–44(–53) cm long, mostly equal or longer than the leaves and the inflorescences conspicuous; corollas purple to lavender; inflorescence rachis (4–)5–13 cm long, (20–)45–160-flowered ..... 2. **Liriope graminifolia**
4. Scapes 12–29 cm long, mostly much shorter than the leaves and the inflorescences mostly obscured; corollas mostly white; inflorescence rachis 2–5(–8) cm long, (20–)45–72-flowered ..... 4. **Liriope spicata**

1. Flowers nodding, on a recurving pedicel/floral tube, corollas mostly campanulate; ovaries inferior to semi-inferior (flowers epigynous to perigynous); anthers more or less connate in a column, narrowly lanceolate in outline, apically narrowly attenuate-acute, dehiscing longitudinally, filaments much shorter than the anthers (anthers subsessile); stigmas 3-lobed; fruits commonly blue, sometimes blackish ..... **OPHIOPOGON**

5. Leaves 2–4 mm wide; scapes 6–12 cm long, much shorter than the leaves; inflorescence rachis 2–5 cm long, 5–10+-flowered; plants colonial ..... 1. **Ophiopogon japonicus**
5. Leaves 4–15 mm wide; scapes (12–)15–50 cm long, shorter or longer than the leaves; inflorescence rachis (2.5–)4–16 cm long, 10–32-flowered or 45–250-flowered; plants colonial to weakly colonial.

6. Leaves blackish purple to black in popular horticultural forms, 4–9(–12) mm wide, (10–)25–36 cm long; 10–32-flowered; plants strongly colonial ..... 2. **Ophiopogon planiscapus**
6. Leaves green or variegated, 7–15 mm wide, (20–)25–60 cm long; 45–250 flowered; plants weakly colonial.

7. Rachis 6–10.5 cm long, fascicles 12–20; flowers 3–7 per fascicle calyx tube (perigone) 6–8 mm long; pedicels (in flower) 9–11 mm long; leaves green or variegated ..... 3. **Ophiopogon jaburan**
7. Rachis (8–)17–21 cm long, fascicles (30–)45–55; flowers (1–)3–6 per fascicle; calyx tube (perigone) 1–2 mm long; pedicels (in flower) 2–5 mm long; leaves variegated ..... 4. **Ophiopogon intermedius**

1. **LIRIOPE MUSCARI** (Decne.) L.H. Bailey, Gentes Herb. 2: 35. 1929. *Ophiopogon muscari* Decne., Fl. Serres Jard. Eur. 17: 181. 1867–1868. **TYPE**: China ("Habitat in insula Hong Kong?").

Convallaria spicata Thunb. in Murray, Syst. Veg., ed. 14, 334. 1784 [also in Fl. Jap. 141. 1784]. *Ophiopogon spicatus* (Thunb.?) Ker Gawl., Bot. Reg. 7: pl. 593. 1821 [nom. invalid.] [non Hook. 1862]. *Liriope muscari* (Decne.) L.H. Bailey var. *exiliflora* L.H. Bailey [nom. nov.], Gentes Herb. 2: 37. 1929. *Liriope exiliflora* (L.H. Bailey) H. Hume, Baileya 9: 144. 1961. *Liriope muscari* forma *exiliflora* (L.H. Bailey) H. Hara, J. Jap. Bot. 59: 37. 1984. **TYPE**: Japan. "Crescit prope Nagasaki" (fide Flora Japonica, p. 141), *C.P. Thunberg s.n.* (holotype: UPS digital image!, Figs. 1 and 2 of present account, photograph in Bailey 1929 as Fig. 7); probable isotypes: BM digital images!, the plants represented only by scapes).

Wang and Tang (1951) proposed the combination *Liriope platyphylla* var. *exiliflora* (Bailey) Wang & Tang, but they did not provide the basionym and the name is invalid. See further comments below, under "The status of the name *Liriope exiliflora*."

Liriope graminifolia (L.) Baker var. *densifolia* Maxim. ex Baker, J. Linn. Soc., Bot. 17: 500. 1879. *Liriope spicata* (Thunb.) Lour. var. *densifolia* (Maxim. ex Baker) C.H. Wright, J. Linn. Soc., Bot. 36: 79. 1903. **TYPE**: "Japonia, Formosa, China borealis, et insulae Loo Choo." As synonym fide Chen and Tamura (2000b), Tamura (in press).

Ophiopogon spicatus (Thunb.) Ker Gawl. var. *communis* Maxim., Bull. Acad. Imp. Sci. Saint-Petersbourg 15: 85. 1871. *Liriope muscari* var. *communis* (Maxim.) Nakai, Bot. Mag. (Tokyo) 43: 776. 1934. *Liriope muscari* var. *communis* (Maxim.) P.S. Hsu & L.C. Li, Acta Phytotax. Sin. 19: 460. 1981. **TYPE**: Japan. Possible isotype: Prov. Senano et Nambu, 1864, 1865, and 1866, *S. Tschonoski s.n.* (NY digital image!); a probable duplicate of this, but giving the date as 1864 and the collection number as *Tschonoski 1874*, is at P, digital image!. Basal parts not collected. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Liriope yingdeensis R.H. Miao, Acta Sci. Nat. Univ. Sunyatseni 1982: 75. 1982. **TYPE**: China, Guangdong Province. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Stolons usually absent, short if present. **Roots** with tuberous swellings but usually few, sometimes absent. **Leaves** (15–)24–55(–65) cm long, 6–12(–23) mm wide, stiff and erect to flexuous and arching, (5–)12–25-nerved, margins minutely serrate distally, apices acute to obtuse or rounded. **Scapes** erect, 24–60(–70) cm long, at least some distinctly longer than the leaves, others often shorter, sometimes all about the same height as the leaves, subterete to slightly flattened, especially distally, or distinctly flattened proximally and distally, green to purple. **Inflorescence** (50–)100–220(–300) flowered, rachis 6–20 cm long, narrowly columnar to broadly cylindric with loosely to densely arranged fascicles; bracts lanceolate to triangular, proximal 3–6 mm long. **Flowers** mostly in fascicles of (1 or 2–)3–?, usually reduced to (1–)2–5 distally; pedicels (2–)3–5 mm long; tepals purple, lilac-purple, or lavender, elliptic-oblong to oblong, 3–4 mm long; floral tube 0.2–0.6 mm long, less commonly essentially absent. **Fruits** globose, 4–8(–9) mm in diam., blue-black to dark or blackish purple to nearly black at maturity. **Seeds** blackish purple at maturity, subglobose, 4–7 mm in diam. $2n = 36, 72, 108, 112$.

Native to China, Taiwan, Japan (including Ryukyu Islands). Native habitats include forests, bamboo forests, scrub, shady and moist places in ravines and on slopes; 100–1400(–2000) meters elevation. **Common names**: **BIG BLUE LIRIOPE, BLUE LILYTURF, BLUE-FLOWERED SNAKESBEARD** (fide Ker Gawler 1821). **Representative cultivars**: Big Blue (later known as Riegel Big Blue and Original Big Blue), Bigun, Blue Spire, Border Gem, California Hybrid, Christmas Tree (sometimes known Monroe No. 2), Cleopatra, C.T. Tanner, Curly Twist, Densiflora, Eleven-O-Three, Gold Banded (v), Grandiflora, Green Midget, Hawk's Feather (v), Ingwersen, Isabelle, Jeanette, John Burch (v), Just Right, King Felix, Lilac Beauty, Majestic, Marant, Marc Anthony, Mayan Blue, Moneymaker, Monroe White (sometimes known as Monroe No. 1), New Blue, New Wonder, Okina, Paul Alden (v), Peedee Ingot, Purple Bouquet, Royal Purple, Silver Banded (v), Silver Dragon (v), Silver Ribbon (v), Silvery Midget (v), Silvery Sunproof (v; see comment under *L. graminifolia*), Sno Cone, Summer Beauty, Superba, Tidwell's Big Blue (now marketed as Tidwell's True Blue), Traebert White, Variegata (v), Webster Wideleaf. Flowering (Jun–)Jul–Aug. "(v)" = variegated.

Naturalized distribution in the USA. **Alabama**, **Georgia**, **Kansas**, **Louisiana** (Lincoln Par., Thomas & Allen 1993), **Maryland**, **Mississippi**, **South Carolina**. A report of *Liriope muscari* from Louisiana (MacRoberts et al. 2008); proved to be *L. spicata*, and it seems likely that at least some others also are misidentifications of stoloniferous species. For example, images of 'infestations' of monkeygrass identified as *L. muscari* (Forestry Images 2010; no indication of provenance except "United States") probably are *L. spicata*. On the other hand, at least one Florida collection (Wunderlin & Hansen 2008) identified as *L. spicata* apparently is *L. muscari* — Jackson Co.: *Burks 1125*, USF; the identification of *Wilhelm 10159* —from Okaloosa Co., USF — as *L. spicata* probably is correct. Diggs et al. (1999) noted that *L. muscari* in north central Texas is widely cultivated and persists and spreads vegetatively in flower beds — the characterization of its vegetative spread suggests that a stoloniferous species (e.g., *L. spicata* or *L. graminifolia* vs. the primarily caespitose *L. muscari*) was included in the concept.

Deputy (1999) noted that Tidwell's Big Blue is a "spreading form … not to be confused with the clumping type Big Blue." Paul Fantz (pers. comm. 2010) also observed that two plants of Tidwell's Big Blue, obtained from Tidwell's Nursery in 1987 and grown in research plots, proved to be stoloniferous. Tidwell's Nursery (pers. comm. 2010, fide "Bo" Tidwell) affirms that at least Tidwell's True Blue as now marketed is a 'clumping' form. See other comments on variability in stolon production — under "Notes on species biology" and with photos in the Online Appendix. It even seems a distinct possibility that some cultivars currently marketed as *L. muscari* may have been derived from forms of *L. graminifolia* in which stolon production has been repressed or restrained. Evidence for this might be sought through molecular studies.

The wide variation in cultivars in habit and other features at least suggests that the genetic pool of *Liriope muscari* may be greater than in other liriopes. As noted by Fantz (2008b, p. 347), "This is the only species with inflorescence variations that have lead to distinct cultivar selections." Consideration of *L. platyphylla* as a species distinct from *L. muscari* (see below) also emphasizes the taxonomic complexity of the lattter, and it seems likely that critical study may bring to light additional taxa that can be justifiably recognized.

Status of the name *Liriope exiliflora*.

Bailey (1929) explicitly noted that his *Liriope muscari* var. *exiliflora* was intended as a nomen novum (a replacement name at different rank) for *Convallaria spicata* Thunb. In Hume's recognition of the taxon at species rank, the prior publication of *Lirtope spicata* Lour. (1790) blocked usage of Thunberg's epithet in the genus *Liriope*.

Chen and Tamura (2000a) interpreted the name *Liriope spicata* Lour. as a combination by Loureiro based on *C. spicata* Thunb. As observed by Bailey (1929), however, *Convallaria spicata* Thunb. (the type from Japan) and *Liriope spicata* Lour. (the type probably from China) are heterotypic and represent different species.

The application of the name *Liriope exiliflora* to the plants commonly cultivated in the USA stems from the interpretation by Hume (1961). From a photo of the UPS type of *Convallaria spicata* Thunb., which Bailey had renamed as *L. muscari* var. *exiliflora*, Hume was convinced that the plant shows "a piece of rhizome attached to the base of the segment" and thus would be a match for the colonial species that he saw in cultivation. Dr. Mats Hjertson, UPS Curator, has sent high resolution images of the UPS specimen (Figs. 1 and 2in the present account) — the thickened axis from the base interpreted by Hume as a rhizome is instead a cord-like fibrous root, probably contractile in function. The type specimen of *Convallaria spicata* can be matched in aspect to many plants of *L. muscari* seen in cultivation.

Reservations earlier expressed by Skinner (1971, p. 348) about the recognition of *Liriope exiliflora* can now be seen as well-founded: "Its origin is obscure. H.H. Hume has accorded it species rank, but a cultivar designation would have seemed more logical, pending assignment to a known existing species."

In raising *Liriope exiliflora* to specific rank, Hume contrasted it in tabular form with *L. muscari*. Another stoloniferous species, *L. graminifolia* was also included in Hume's overview, and a comparison of his description of *L. graminifolia* -**vs.**- *L. exiliflora* shows this: leaves 35–40 cm long, 3–5 mm wide, 9–11-nerved -**vs.**- "to 43 cm" long, 9–12 mm wide, 9–13-nerved; rachis 3.5–6.2 cm long -**vs.**- 8–16.5 cm long; fascicles ?, mostly 3-flowered -**vs.**- 3–5, mostly 5-flowered. The leaf width described by Hume for *L. exiliflora* matches the leaves of the type specimen (= *Convallaria spicata*, Thunb.) but is considerably broader than the dimensions recorded by Fantz (2008b) and those here for the cultivated stoloniferous species identified as *L. exiliflora*. Thus even the identity of the American plants regarded by Hume as *L. exiliflora* is not perfectly clear in his concept, and a distinct species identified as *L. exiliflora* has never been recognized in Japan, even a half century after its taxonomic uplift by Hume. As concluded here, the plants identified by Hume as *L. exiliflora* are forms of *L. graminifolia* (see discussion below), the type of which is from somewhere in Asia outside of Japan, since *L. graminifolia* does not occur in Japan.

In both the original and revised edition of his Manual of Cultivated Plants, Bailey included only two species, *Liriope spicata* and *L. muscari*, treating var. *exiliflora* within the latter (Bailey 1924, 1949) as a form with leaves "often only 6 mm broad but sometimes nearly twice as broad."

Both *L. exiliflora* and *L. graminifolia* are listed in Hortus Third (Bailey Hortorium Staff 1976), the latter noted as "probably not in cultivation" (perhaps just repeating earlier comments).

Placement of *Liriope exiliflora* as a synonym of *L. muscari* accounts for several previous discrepancies: (1) the morphological discordance between the type specimen of *Convallaria spicata* Thunb. and plants identified as *L. exiliflora* in the American horticultural trade, (2) the absence of plants identified as *L. graminifolia* in the American horticultural trade, and (3) the absence of a distinctive species identified as *L. exiliflora* in Japan, where the type specimen was collected. For the Flora of Japan, Tamura (in press) has treated *Liriope muscari* var. *exiliflora* L.H. Bailey as a synonym of *L. muscari* sensu stricto, and the present study is in agreement.

Status of *Liriope platyphylla*.

Liriope platyphylla was proposed as a new species in 1951 and the name has engendered taxonomic confusion, especially after being used by Ohwi (1953) for all of the *L. muscari*-like plants of Japan. Recent Asian floras (Chen & Tamura 2000a; Tamura in press) have placed *L. platyphylla* in synonymy under *L. muscari*, but it has been maintained as a species distinct from *L. muscari* by Fantz (2008b), who observed that "Plants bearing the name *L. platyphylla* originating from China or European nurseries (who obtained them from China) are very distinct from cultivated selections of U.S. plants known as *L. muscari*" (p. 345). And (p. 348) "The inflorescences overtop the leaves much higher than *L. muscari*, bearing more fascicles of flowers than any other species. However, fruiting pedicels will bear dried, persistent perianth members, which is less desirable as an ornamental trait when fruit typically abort. Rabbits continually ate the leaves of this species in research beds, ignoring *L. muscari* and other species, which exhibited infrequent feeding."

Liriope platyphylla F.T. Wang & T. Tang, Acta Phytotax. Sin. 1: 332. 1951. **SYNTYPES**: China: Anhwei, *T.N. Liou & P.C. Tsoong 2077*; Kiangsu, *Y.L. Keng 2749* — cited by Wang and Tang as "Type specimens." The herbarium of deposition was not specified for either, but the authors were working from "Academia Sinica" and presumably the specimens are at PE in Beijing. Fantz (2008b) noted that he had not been able to obtain type material for study

Liriope spicata var. *latifolia* Franch., Pl. David. 296. 1884. **TYPE**: China. Kiangsi, Kiukiang Mountains, *A. David 854* (P). As synonym fide Chen and Tamura (2000b), Tamura (in press).

Liriope muscari forma *latifolia* (Makino) H. Hara, J. Jap. Bot. 59: 37. 1984. *Liriope graminifolia* var. *latifolia* Makino, Yagaihakubutsu 3: 165. 1933. **TYPE**: Japan.

In synonymy of *Liriope platyphylla*, Wang and Tang cited "*Liriope muscari* Bailey [1929] non *Ophiopogon muscari* Decne. [1868]," but Bailey's name as a new combination was clearly based on Decaisne's basionym and thus is homotypic with it. The authors described their new species as "rhizomatosa," and it is possible that they conceived of it as distinct in growth habit from "*Liriope muscari* sensu Bailey." They also cited in synonymy "*Ophiopogon spicatus* Hook. [1862] non *Liriope spicata* Lour." (thus referring to *Convallaria spicata* Thunb. = *Liriope exiliflora*, see comments below — which is stoloniferous). Even if they were proposing *L. platyphylla* as a replacement name for *Convallaria spicata*, Bailey had already provided that in 1929 as *L. exiliflora*. In any case, citation of *L. muscari*, a valid species heterotypic with *L. platyphylla*, in synonymy of *L. platyphylla* appears to render the latter invalid. (617) 495-0794

Among collections from the Harvard Herbaria, I have seen duplicates of several cited by Wang and Tang as paratypes of *Liriope platyphylla*: [China]. Chekiang, *Cheo & Wilson 2805* (GH); Hunan, *Fan & Li 565* (GH); Kweichow, *Steward, Chiao, & Cheo 77* (A, GH). From these, and from the illustration in Wang and Tang (1978), the description in the protologue, and the implication of the epithet, it appears that *L. platyphylla* refers a relatively broad-leaved variant that is treated by current floristicians in China and Japan as a synonym of *L. muscari* — representative collections of this form

are shown in Figs. 5 and 6, compared to collections of typical *L. muscari* in Figs. 3 and 4. I have seen collections generally matching the *L. platyphylla* variant from Japan and Taiwan and a cluster of provinces of southeastern China (Jiangsu, Anhui, Zhejiang, Jiangxi, Hunan, and Guangxi). Typical *L. muscari* appears to be restricted to eastern provinces of China (Shandong, Jiangsu, Anhui, Jiangxi, Zhejiang, Jiangxi, Fujian, Guangdong, and Hainan) and it also occurs in Japan and Taiwan. I am not able to adequately assess whether or not intergradation indicates that *L. platyphylla* and *L. muscari* are conspecific.

The original description of *Liriope platyphylla* noted that it is rhizomatous, but none of the plants I have seen that otherwise match *L. platyphylla*, either cultivated or from the native range, have been rhizomatous. Fantz (2008b) characterized the species as caespitose and forming tufted clumps.

Some variants in the USA horticultural trade match the leaf morphology of *Liriope platyphylla*. Fantz's key (2008b) key does not directly compare *L. platyphylla* and *L. muscari*, but the couplet below is derived from his key and descriptions.

1. Scapes 55–60 cm long; rachis 18–24 cm long, crowded, ca. 3/4–4/5 as long as the peduncle; fascicles 60–80; perianth tube prominent, 1–1.2 mm long; corollas lavender; anthers 1.6–1.8 mm long; outer bracts obovate-elliptic, hyaline wings to near apex ..... **Liriope platyphylla**
1. Scapes 20–30 cm long; rachis 6–12 cm long, loose, ca. 1/3 as long as the peduncle; fascicles 35–50; perianth tube inconspicuous, 0.1–0.4 mm long; corollas violet to purple or white; anthers 1.5 mm long; outer bracts linear with abrupt, ovate, hyaline wings basally ..... **Liriope muscari**

It may be possible to recognize another broad-leaved variant of *Liriope muscari* sensu lato. Plants with exceptionally long, thick leaves and long scapes (see representatives in Figs. 7 and 8) occur in provinces mostly west of the "platyphylla" variants (Sichuan, Yunnan, and Guizhou, and overlapping or parapatric with "platyphylla" in Hunan). The leaves are relatively even in width rather than prominently broadening distally as in the "platyphylla" form. More detailed study would be necessary to accurately portray the variation.

2. LIRIOPE GRAMINIFOLIA (L.) Baker, J. Linn. Soc., Bot. 14: 538. 1875. *Asparagus graminifolius* L., Sp. Pl., ed. 2, 1: 450. 1762. *Dracaena graminifolia* (L.) L., Syst. Nat. (ed. 12) 2: 246. 1767. *Mondo graminifolium* (L.) Koidz., Bot. Mag. (Tokyo) 40: 333. 1926. *Ophiopogon graminifolius* (L.) H.R. Wehrh., Gartenstauden 1: 187. 1929. **TYPE**: "Habitat in Asia."

A type has not been designated for *Asparagus graminifolia* (fide Jarvis 2007), but original material is in herbarium LINN (Savage No. 435.5 digital image!; <http //www linnean-online org/5244/>). The plant is in flower, clearly *Liriope*, and has narrow leaves (2–2.5 mm wide) and 11–25 cm long. The inflorescence overtops the leaves — the scape (peduncle plus rachis) is 27 cm long and the rachis is 11 cm long. The fascicles are well-separated and each is composed of (1–)2–4 flowers with ovate floral bracts; the flowers total about 85. The basal parts of the plant, critical in its identification, were not collected but the narrowly linear leaves and overtopping inflorescence give some confidence that it represents the species currently identified in Asia as *L. graminifolia*.

Liriope crassnuscula Ohwi, Acta Phytotax. Geobot. 12: 108. 1943. **TYPE**: China. As synonym fide Chen and Tamura (2008a).

Stolons creeping, slender (fide protologue and observation). **Roots** with tuberous swellings. **Leaves** (14–)18–54 cm long, (2–)3–8(–10, –12 fide Fantz) mm wide, flexuous and arching, (6–)8–15-nerved, margins minutely serrulate distally, apices acute to obtuse to rounded. **Scapes** erect, (15–)20–44(–53) cm long, usually longer than the leaves, sometimes subequal to slightly shorter, subterete to

strongly flattened, especially distally. **Inflorescence** (20–)45–160-flowered, rachis (4–)5–13 cm long, narrowly columnar with distinctly separated fascicles; bracts ovate, proximal 4–5 mm long. **Flowers** in fascicles of (1–)2–7, usually 1–3 distally; pedicels 2–5 mm long; tepals light purple to lavender, oblong to oblong-elliptic, 3–4 mm long; floral tube 0.5–1 mm long. **Fruits** globose, 4–5 mm in diam., blackish at maturity. 2n = 72, 108.

Native to Pakistan and northwestern Himalayas, Vietnam, and China (incl. Taiwan). Native habitats include forests, thickets, shady places along ravines, grassy and rocky places; ca. 10–2300 meters elevation. **Common names**: **GRASS LILYTURF, CREEPING LILYTURF. Representative cultivars**: Angustifolia, Ariaka-janshige (v =Silvery Sunproof?), Samantha ("pink liriope"). Some commercial websites equate the names Ariaka-janshige and Silvery Sunproof; a few describe it as "spreading" but photos mostly show caespitose plants. Flowering (Jul–)Aug–Sep.

Reported here for the first time (see below) as outside of cultivation in the USA. Hume (1961, p. 147) noted that "In the Lower South it [*Liriope exiliflora* sensu Hume = *L. graminifolia*] is commoner than any other species of *Liriope*." Fantz (2008) also noted that it is very common in the landscape, and the present study confirms its abundance in cultivation, at least in Texas, Louisiana, and Arkansas.

In a taxonomic account of the Asparagaceae, Baker (1875) disposed of various names outside of his concept of *Dracaena*. His entry for the liriope was this: "D. GRAMINIFOLIA, *L.* = Liriope graminifolia, *Baker*. = Ophiopogon spicatus, *Gawl*." Fantz (2008b) treated *Liriope graminifolia* as a synonym of *L. spicata* Lour., acceding to a precedent that he cited from the 2007 International Plant Names Index (IPNI), but Baker's citation of "*Ophiopogon spicatus* Gawl." would have been in reference to the basionym *Convallaria spicata* Thunb., which is regarded here as a synonym of *L. muscari*.

Examination of the types of *Liriope graminifolia* (L.) Baker and *L. spicata* Lour. (see references above to the images) indicates that they are not the same species (and, of course, the Linnaean name is the earlier). *Liriope spicata* is distinguished by its longer and narrower leaves, shorter scapes (relative to the leaves), much shorter and fewer-flowered rachises, and white flowers. The description of *L. graminifolia* formulated here from first-hand observations of cultivated plants in the USA is remarkably similar to the description of *L. graminifolia* in the Flora of China (Chen & Tamura 2000a), presumably based on a wide geographic sample of native plants.

Liriope graminifolia and *L. muscari*, as identified here, are similar in aspect and can easily be confused in identification, especially if the stolons of *L. graminifolia* are restrained by a barrier from spreading — in both species the scapes characteristically overtop the leaves and the flowers are purplish. The only consistent diagnostic feature is the growth habit, stoloniferous in *L. graminifolia*, caespitose in *L. muscari*. Fantz (2008, p. 346) described a useful technique for observing the difference without digging: "A good field observation is to use your hands to separate the leaves in a *Liriope* patch from above. It will be easy to observe patches of bare soil between bibs within the clump of [*L. graminifolia*] because of its rhizomatous [stoloniferous] habit. The bibs will be close together in caespitose *L. muscari*, making patches of bare soil more obscured or hidden."

Fantz also noted that "abundant fruit set also indicates *Liriope* [*graminifolia*], as fruit commonly abort in *L. muscari*, leaving pedicellate racemes lacking or bearing very few fruit."

***Liriope graminifolia* naturalized in Texas.**

The account here is the first report of *Liriope graminifolia* naturalized in the USA.

Texas. Tarrant Co.: city of Euless, Bob Eden Park along S side of West Mid Cities Blvd., low woods of *Ulmus americana*, *Carya illinoiensis*, *Quercus shumardii*, *Fraxinus pennsylvanica*, and *Morus rubra*, along slough immediately tributary to large creek, producing abundant fruit, 10 Oct 2010, *Nesom FW10-25* with Robert George (BRIT).

A single large plant with stoloniferous offsets was encountered (see photos in Online Appendix). There is no obvious source for the species in the immediate vicinity but large amounts of water move through the habitat in heavy rains and it is possible that a plant fragment was washed into the site from a neighborhood outside the park. *Liriope graminifolia* was observed in cultivation in a nearby neighborhood. Reproduction through seed is possible, especially in view of the abundant fruit production — but then one might expect that escapes would be more commonly reported, since the species is so commonly cultivated in the Southeast. Fruits of the isolated plant in Bob Eden Park perhaps were developed apomictically.

3. **LIRIOPE GIGANTEA** H.H. Hume, Baileya 9: 148. 1961. **TYPE**: Presumably Asia, but provenance otherwise unknown. "The source from which it came originally is obscure. It was found growing in a small area near the house at Millpond Plantation, Thomasville, Georgia. Mr. A.F. Wilkinson, who was superintendent of Millpond Plantation for 40 years, says in a letter dated October 21, 1960, that 'The original Ophiopogons, I believe, came from France when the gardens were first landscaped some 54 years ago.' This would place the planting at Millpond in 1906 or thereabouts" (Hume 1961, p. 150). The holotype is housed at FLAS and a digital image! can be seen on the FLAS herbarium website.

Stolons creeping, slender (fide protologue), but apparently without stolons in at least most horticultural forms. **Roots** with or without tuberous swellings. **Leaves** (17– fide Fantz, 30–)50–80 cm long, (5–)8–12(–16 fide Fantz) mm wide, thicker and less arching than in other liriopes, 7–13(–17 fide Fantz)-nerved, margins minutely serrulate distally, apices acute to obtuse to rounded. **Scapes** erect, 20–42 cm long, mostly shorter than the leaves, subterete to slightly flattened, especially distally, purplish. **Inflorescence** ca. 40–180-flowered, rachis 6–17 cm long, narrowly columnar with distinctly separated fascicles; bracts lanceolate to linear, proximal 4–5 mm long. **Flowers** mostly in fascicles of (2–)4–8; pedicels 3–5 mm long; tepals light to dark violet, oblong-ovate, 4–6 mm long; floral tube 0.3–1 mm long or less commonly essentially absent. **Fruits** subglobose, 5–8 mm in diam., blue-black to dark or blackish purple at maturity. **Seeds** subglobose, 4–6 mm in diam. $2n$ = unknown.

Native distribution unknown (see comments below and those regarding the **TYPE**). **Common names**: **GIANT LILYTURF, GIANT LIRIOPE**. **Representative cultivars**: Aztec Grass, Emerald Goddess, Evergreen Giant, Love Potion No. 13, Merton Jacobs, Supergreen Giant. Fantz (2008b) notes that "Variegated Giant," sometimes claimed to be a horticultural variant of *L. gigantea*, is actually an *Ophiopogon* (*O. jaburan*). Flowering Jun–Oct. As noted by Hume (1961, p. 150): "flowers produced earlier in the season than those of any other species growing under same conditions; fruit also ripening ahead of that of *L. muscari*, *L. spicata*, *L. graminifolia*, and [*L. graminifolia*]." Broussard (2007), however, noted that it flowers June through September; cultivars in Texas were flowering through September, essentially contemporary with *L. graminifolia*, mostly later than *L. spicata*.

The description above of *Liriope gigantea* is drawn mostly from plants seen by the author sold and cultivated as 'giant liriope' (and usually identified as "*Liriope gigantea*"), augmented mostly

for fruits from the description by Fantz (2008b). Comments by Fantz (2008b, p. 346) are useful: "The leaves are stiff, mostly erect with some spreading apically, but not becoming arched back and pointed downward toward the ground as observed in most species of liriopogons. The leaves are the longest and the most elegant green of liriopogons used in the landscape." I find that *L. gigantea* is eaily distinguished from *L. muscari*, but the distinction is subtle and relies mostly on leaf length and thickness.

In the protologue of *Liriope gigantea* (Hume 1961) it was described as a "rhizomatous plant with stout, widely spreading rhizomes, in time forming a dense matted turf." The type specimen at FLAS (cited above), as well as the photo in the protologue (Hume 1961, Fig. 55, p. 147) clearly show slender, creeping rhizomes. Broussard (2007) studied samples of *Liriope gigantea* and also described the root system as "rhizomatous with stout, widely spreading rhizomes." Photos of her vouchers ("Evergreen Giant" Fig. 4.7; Merton Jacobs "Supergreen" Fig. 4.19) show rhizomatous (= stoloniferous) plants. The patent application for "Merton Jacobs" (Jacobs 2001) notes that it grows "by adding bibs or small clumps of leaves on short rhizomes on the side of the existing clump. … The rhizomes are 1/2 to 3/4 inches long, 1/4 to 1/2 inches wide. … [The original of the new cultivar was] "found as an openly pollinated seedling of *Liriope gigantea* maintained by Flowerwood Nursery, Inc. in Bushnell, Fla." (Jacobs 2001).

In contrast, Fantz's description noted that "rhizomatous stems lacking" is characteristic of the growth habit of *Liriope gigantea*, and commercial information generally describes plants with a clumping habit, sometimes reaching three feet in width from lateral growth. All of those I have seen also appear to be distinctly caespitose, without rhizomes (see photos in Online Appendix). Thus it appears that the spreading growth habit is variable in derivatives of typical *L. gigantea*. See comments under *L. muscari*, in which similar variation perhaps occurs.

The lack of correspondence of *Liriope gigantea* with any known Asian species is peculiar. Comments by Skinner (1971, p. 348–349) are pertinent: "This, the largest-leaved of all known wild or cultivated liriopogons, is an oddity which may possibly have reached a Georgia plantation from France early in the century. Yet it seems not to have been reported from France. … It may well be of garden origin." With Fantz and others, however, the present study confirms that *L. gigantea* is a distinctive entity not clearly associated with any other species cultivated in the USA and apparently not matching any recognized species of the Chinese or Japanese flora.

If *Liriope gigantea* indeed is of garden origin, it seems reasonable to speculate that it has arisen from *L. muscari*. Plants of *L. gigantea* are generally larger than those of *L. muscari*, usually considerably so, but large-leaved plants of *L. muscari* sensu lato may be similar in aspect to *L. gigantea*, overlapping in leaf length and width (e.g., see the variant from south-central China in Figs. 7 and 8). Leaves of *L. gigantea* are thicker and more rigid (also as noted by Fantz 2008b) and the flowers are larger. This set of "gigas" features could be associated with an elevated ploidy level. Variation in habit (stolons present or absent) suggests the possibility that distinct cultivars may have arisen independently. Hybrid origin is not implausible — all plantings I have seen (Texas and Arkansas) have been completely sterile, with no fruit production.

4. LIRIOPE SPICATA Lour., Fl. Cochinch. 1: 201. 1790 (non *Convallaria spicata* Thunb. 1784, based on a type from Japan; see comments under *L. exiliflora*). **TYPE**: probably China. "Habitat frequenter culta, incultaque in Cochinchinâ, & Chinâ" (holotype: P, photograph in Bailey 1929, Figure 6).

Ophiopogon gracilis Kunth, Enum. Pl. 5: 298. 1850. **TYPE**: Vietnam and China. As synonym fide Tamura (in press).

Ophiopogon fauriei H. Lév. & Vaniot, Repert. Spec. Nov. Regni Veg. 5: 283. 1908. *Mondo fauriei* (H. Lév. & Vaniot) Farwell, Amer. Midl. Naturalist 7: 43. 1921. **TYPE**: Korea. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Liriope spicata var. *prolifera* Y.T. Ma, J. Wuhan Bot. Res. 3: 27. 1985. **TYPE**: China. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Liriope spicata var. *humilis* F.Z. Li, Bull. Bot. Res., Harbin 6: 170. 1986. **TYPE**: China. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Stolons creeping, slender. **Roots** with tuberous swellings. **Leaves** (15–)25–60 cm long, 3–6(–8) mm wide, flexuous and arching, 5–11-nerved, margins serrulate, apices acute. **Scapes** erect, 12–29 cm long, shorter than the leaves, terete to slightly flattened, especially distally. **Inflorescence** 45–72-flowered, rachis 2–5(–8) cm long, narrowly columnar with distinctly separated fascicles; bracts lanceolate to linear, 4–6 mm long. **Flowers** in fascicles of (1–)2–4(–6); pedicels ca. 2 mm long; tepals white to very pale violet, oblong-elliptic to oblong, 4.5–5 mm long; floral tube 0.5 mm long. **Fruits** globose, 7–9 mm in diam., blue-black to dark or blackish purple at maturity. **Seeds** subglobose, 5–6 mm in diam. $2n = 36, 72, 88, 90, 108$.

Native to China, Taiwan, Japan, Korea, and Vietnam. Native habitats include forests, grassy slopes, hillsides, moist places; ca. 10–1800 meters elevation. **Common names**: **CREEPING LIRIOPE, CREEPING LILYTURF, TABLE GRASS**. **Representative cultivars**: Cassidy, Ever Blue, Franklin Mint (or =*L. muscari*?), Small Dragon, Silver Dragon (= Gin Ryu) (v), Small Green. Flowering (Jul–)Aug–Sep(–Oct).

Naturalized distribution in the USA. **Alabama** (Spaulding et al. 2010). **Arkansas** (reported by Smith 1988 as *Ophiopogon jaburan*, but ID'ed here as *L. spicata*. Jefferson Co.: Pine Bluff, invading vigorously in a yard, 16 Aug 1983, *Locke 5235*, UARK digital image!). **Florida** (Wunderlin & Hansen 2008; voucher for occurrence in Wakulla Co., *Anderson 24303*, VDB). **Louisiana** (Caddo Par.; MacRoberts et al. 2008, identified in the original report as *L. muscari*). **Maryland** (Calvert Co.: Scientists Cliffs, Port Republic, occasional escape along Steve Easter Trail, E of picnic table, colonial herb, 12 Oct 1986, *Hill 17478* (GH). **Mississippi**, **Illinois**, **Texas** (see notes below for Texas).

Liriope spicata is a distinctive species identified with certainty by its rhizomatous habit, narrow, arching leaves, and short scapes bearing inconspicuous inflorescences usually about mid-level among the leaves. The flowers are white to very pale violet and relatively few per rachis.

Comments on the name *Liriope spicata*.

In making the nomenclatural combination *Ophiopogon spicatus*, Ker Gawler (1821) listed both *Liriope spicata* Lour. and *Convallaria spicata* Thunb. as synonyms, thus the name is invalid and the basionym for his combination is ambiguous — the listing here with Thunberg's basionym is arbitrary. He noted that "The synonym from the 'Flora Cochinchinensis" was kindly communicated by Mr. Brown, who has ascertained it from the original sample in the Herbarium of the Museum of Natural History at Paris; where a portion of Loureiro's Botanical Collection had found its way from Lisbon during the pillage of the late wars." The illustrated plant (plate 593), however, clearly is not *L. spicata* Lour. It probably represents *L. muscari* or *L. graminifolia* — although the description notes "radice repente," the basal parts are not illustrated, thus its identity is unambiguous, The illustrated leaves are broader than characteristic of *L. graminifolia* but no measurements are given in the description. Ker Gawler cited "Nepal, Cochinchina, China, and Japan" as the native range of the species, apparently incorporating elements from the protologues of both Loureiro and Thunberg. He noted that the illustrated plant was introduced in 1820 by the Horticultural Society of London and grown in their conservatory — with only the generalized statement as an indication of its native provenance.

Hooker (Bot. Mag. 88: t. 5348. 1862) provided an illustration and commentary associated with the name *Ophiopogon spicatus*, and the name sometimes has been cited as "*O. spicatus* (Thunb.) Hook. 1862." Hooker, however, clearly did not intend to provide a new name, as he cited *O. spicatus* "Gawl." The illustration in Hooker's contribution probably is of *L. muscari* (the basal parts are not shown or described), and regarding the previous illustration in Ker Gawler's article, Hooker noted that "Gawler's artist has not done justice to the plant in his figure" (which also does not illustrate basal parts).

***Liriope spicata* naturalized in Texas.**

The occurrence of *Liriope spicata* has been attributed to Texas (Kartesz 2010; USDA, NRCS 2010) on the basis of a report by Neill and Wilson (2001). This Texas report, however (p. 1093), described the species as one of several "found in varying stages of persistence at an old abandoned home sites and cemeteries … and not appearing to be adventive;" the label explicitly notes that the specimen was collected from an "Abandoned old home site … persisting after cultivation, rhizomatous-spreading" (Madison Co., 15 Jun 1997 [no flowers or fruits], *Neill 672*, TAMU digital image!). The plants are clearly stoloniferous, with stiffly arching leaves 10–19 cm long and 2–3 mm wide —a collection of *Ophiopogon japonicus* rather than *L. spicata*.

Liriope spicata is unequivocally documented here as outside of cultivation and naturalized in two distantly removed localities in Texas.

1. Texas. Tarrant Co.: city of Fort Worth, Overton Park between the TCU campus and Hulen Street, Overton Creek parallel to Shady Creek Drive, immediately adjacent to the creek on the sandy terrace, 10 Oct 2010, *Nesom FW10-21* (BRIT, MO, NCU, TAMU, TEX, USF).

The plants occur in at least eight large, dense, rhizomatous, well-separated colonies over a stretch of about 200 meters (see photos in Online Appendix) along Overton Creek in Overton Park, near the center of the city of Fort Worth. The creek at this point runs through a broad and wooded but relatively steep-sided ravine and is about three miles above confluence with the Trinity River. The liriope colonies are on the first terrace of the creek.

It is possible that the first plants of *Liriope spicata* along Overton Creek were from a local homeowner who dumped lawn refuse down the steep banks. The creek commonly rises beyond its banks in heavy rain and, once established in the lower terrace, a colony could be fragmented in fast water and parts of it carried downstream.

2. Texas. Hardin Co.: Big Thicket National Preserve, Lance Rosier Unit, on the long east fork of Rosier Park Road (Cotton Road) at the turnaround at the road end near Little Island Bayou, bottomland hardwoods, 21 Aug 2004, *Brown 30092* (SBSC, photocopy!).

Another collection from Hardin County was reported by Brown et al. (2005) as *Ophiopogon jaburan* — the voucher for this collection is presently unavailable for study, but it is very likely to be *Liriope spicata* (in the Big Thicket National Preseve, along the Kirby Nature Trail near Turkey Creek "far from any house or farm land," *Johnson 1797*, RICE transferred to TAES). Diggs et al. (2006) included *O. jaburan* as a member of the East Texas flora on the basis of the report by Brown et al.

Liriope spicata is described on some internet sites as forming an "outstanding weed-suppressing mat," an accurate description also reflective of its behavior in the Fort Worth creekside habitat. Fruits in *L. spicata* are produced at a very low frequency (pers. observ.), however, which probably limits its wider dispersal and invasive potential.

Other species of *Liriope*.

Liriope includes a total of 6–10 species, depending on the taxonomic interpretations of *L. gigantea*, *L. platyphylla*, and *L. koreana*, and *L. tawadae*. Brief notes on remaining taxa are provided here.

Liriope minor (Maxim.) Makino, Bot. Mag. Tokyo 7: 323 1893. *Ophiopogon spicatus* (Thunb.) Ker Gawl. var. *minor* Maxim., Bull. Acad. Imp. Sci. Saint-Petersbourg 15: 85. 1870. *Liriope graminifolia* (L.) Baker var. *minor* (Maxim.) Baker, J. Linn. Soc., Bot. 17: 500. 1879. *Liriope spicata* Lour. var. *minor* (Maxim.) C.H. Wright, J. Linn. Soc., Bot. 36: 80 1903. *Ophiopogon minor* (Maxim.) Masam., Sci. Rep. Kanazawa Univ., Biol. 5: 111. 1957. **TYPE**: Japan. Kanagawa Prefecture. Yokohama, 1862, *C.J. Maximowicz* (probable isotypes: GH!, without collection number, NY digital image!; with the same locality and date but labeled *Maximowicz 1874* (P digital image!).

Liriope cernua (Koidz.) Masam., Mem. Fac. Sci. Taihoku Imp. Univ. 11: 559. 1934. *Mondo cernuum* Koidz., Bot. Mag. Tokyo 40: 332. 1926. **TYPE**: Japan. As synonym of *L. minor* fide Tamura (in press).

Mondo tokyoense Nakai, J. Jap. Bot. 19: 314. 1943. **TYPE**: Japan. As synonym of *L. minor* fide Tamura (in press).

Liriope angustissima Ohwi, Acta Phytotax. Geobot. 3: 201. 1934. *Liriope minor* (Maxim.) Makino var. *angustissima* (Ohwi) S.S.Ying, Fl. Taiwan ed. 2, 5: 53. 2000. **TYPE**: Taiwan. As conspecific with *L. minor* fide Ying (2000); as synonym of *L. graminifolia* fide Chen and Tamura (2008a).

Liriope minor was included in the overview by Fantz (2008b, p. 347), who noted that it is "a rare species in the green industry, found in limited botanic gardens labeled as a cultivar of *Liriope* or *Ophipogon japonicus*." It is stoloniferous-colonial and further unequivocally characterized by its short and narrow leaves and especially by its scapes shorter than the leaves and with short, very few-flowered rachises. The native range of *L. minor* is China, Japan, Korea, and the Philippines. Chinese plants of the species are described with leaves 2–3(–4) mm wide and 7–20 cm long, scapes 6–7(–15) cm long with rachises 1–3(–5) cm long and 5–12 flowers (Chen & Tamura 2000a); in Japan, the leaves are 8–42 cm long, 2–3 mm wide, scapes 3.5–12(–16) cm long with rachises 0.5–5(–9) cm long and 3–17 flowers (Tamura in press). Analogous measurements for *L. minor* by Fantz indicate that his concept of the species is similar: leaves 2–4 mm wide, (5.5–)7.5–15 cm long, scapes 5–8.5 cm long, and rachises 1–2.5 cm long with ca. 3–18 flowers.

Liriope koreana (Palib.) Nakai, Bot. Mag. Tokyo 48: 777. 1934. *Ophiopogon spicatus* var. *koreanus* Palib., Trudy Imp. S.-Peterburgsk. Bot. Sada 19: 106. 1901. *Liriope graminifolia* (L.) Baker var. *koreana* (Palib.) Nakai, Fl. Kor. 2: 239. 1911. *Mondo koreanum* (Palib.) Hatus., Bull. Kyushu Imp. Univ. Forests no. 5: 231. 1934. *Liriope spicata* Lour. forma *koreana* (Palib.) H. Hara, J. Jap. Bot. 59: 38. 1984. **TYPE**: Korea.

Liriope koreana has been treated as a synonym of *L. spicata* by Chen and Tamura (2000b) and Tamura (in press), but in the limited material I have seen (GH: Japan, Shinsyu; Korea, Sorai Beach, Whanghai), plants identified as *L. koreana* do not appear to be the same species as *L. spicata*. The scapes are equal to or longer than the leaves and produce more and smaller flowers than in *L. spicata*, and the leaves are 10–20 cm long and 2–4 mm wide.

Liriope kansuensis (Batalin) C.H. Wright, J. Linn. Soc., Bot. 36: 79. 1903. *Ophiopogon kansuensis* Batalin, Trudy Imp. S.-Petersburgsk. Bot. Sada 13: 103. 1893. *Mondo kansuense* (Batalin) Farwell, Amer. Midl. Naturalist 7: 42. 1921. **TYPE**: China.

Liriope kansuensis is endemic to a relatively small region of central China, in northern Sichauan Province and adjacent Gansu Province. It is distinctive in its stoloniferous habit, short linear leaves, and few-flowered scapes longer than the leaves.

Liriope pedicellata Wang & Tang, Fl. Reipubl. Popularis Sin. 15: 251. 1978. **TYPE**: China.
Liriope pedicellata occurs only at moderate elevations in northeastern Sichuan Province. The plants are characterized by their caespitose habit, long, linear leaves, and as the epithet implies, the distinctively long pedicels.

Liriope tawadae Ohwi, Acta Phytotax. Geobot. 5: 55. 1936. *Ophiopogon tawadae* (Ohwi) Masam., Sci. Rep. Kanazawa Univ. 5(a): 111. 1957. **TYPE**: Ryukyu Islands (Japan, Okinawa).
Tamura (in press) characterizes *Liriope tawadae* as an endemic of the Ryukyu Islands and differentiates it from *L. muscari* by its angled scape and longer pedicels articulated near the apex — but entering the caveat "Further studies are needed in order to clarify whether *Liriope tawadae* is really distinguished from *L. muscari* or not."

5. OPHIOPOGON JAPONICUS (Thunb.) Ker Gawl., Bot. Mag. 27, plate 1063. 1807. *Convallaria japonica* Thunb., Nova Acta Regiae Soc. Sci. Upsal. 3 [Kaempferus Illustratus I]: 208. 1780 [also Fl. Jap., 140. 1784]. *Flueggea japonica* (Thunb.) Rich., Neues J. Bot. (Schrader) 2: 9. 1807. *Slateria japonica* (Thunb.) Desv., Verh. Batav. Genootsch. Kunsten 12: 15. 1830. *Mondo japonicum* (Thunb.) Farwell, Amer. Midl. Naturalist 7: 42. 1921. **TYPE**: Japan, [*C.P. Thunberg 8491*] (holotype: UPS, photo in Bailey 1929 as Fig. 5).

Authorship of *Convallaria japonica* is sometimes attributed to L. f. (Suppl. Pl., 204. 1782), but Thunberg first published the name. Ker Gawler cited Thunberg's publication in Flora Japonica, but the description in Kaempferus Illustratus was two years earlier. Linnaeus cited "Habitat in Japonia. Thunberg." Ker Gawler augmented his description of the species with information from Kaempfer's *Amoenitatum Exoticarum* of 1712.

Convallaria japonica var. *mmor* Thunb., Fl. Jap. 139. 1784. **TYPE**: Japan. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Ophiopogon stolonifer H. Lév. & Vaniot, Mem. Accad. Pontif. Nuovi Lincei 23: 344. 1905 [Liliac. etc. Chine, 16. 1905]. *Mondo stolonifer* (H. Lév. & Vaniot) Farwell, Amer. Midl. Naturalist 7: 42. 1921. **TYPE**: China. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Stolons creeping, slender. **Roots** with tuberous swellings. **Leaves** (5–)12–35(–40) cm long, 2–4 mm wide, 3–5(–7)-nerved, margins serrulate, apices acute to obtuse or rounded. **Scapes** erect, 6–15(–27) cm, much shorter than leaves, slightly flattened. **Inflorescence** ca. 5–10+-flowered, rachis 2–5 cm; bracts lanceolate, proximal 7–8 mm long. **Flowers** usually nodding, in fascicles of 1–2(–3); pedicels 2–2.5 mm, articulate near middle; tepals white to light lilac or pale purple, lanceolate, 3.5–4.5 mm long; floral tube 1–2 mm long. **Fruits** subglobose to ellipsoid-globose, ca. 7–9 mm in diam., blue to blue-violet at maturity. **Seeds** globose, 6–8 mm in diam., blue at maturity (photos in the Online Appendix). $2n = 34, 36, 67, 68, 72, 108$.

Native to China (incl. Taiwan), Japan, and Korea. Native habitats include forests, dense scrub in ravines, and moist and shady places on slopes and along streams, cliffs; 200–2800 meters elevation. Widely cultivated in China for its tuberous roots, which are used medicinally. **Common names**: **MONDO GRASS, MINI MONDO, DWARF MONDO, SUPER DWARF MONDO, ENGLISH MONKEYGRASS**. **Representative cultivars**: Albus, Bluebird, Caeruleus, Comet (v), Compactus, Gyoko Ryu, Jade Dragon, Kijimafukiduma (v), Kyoto Dwarf, Minor, Nanus, Nippon, Silver Mist (v, = Kijimafukiduma?), Silver Showers (v), Shiroshima Ryu, Striatus, Super Dwarf, Tears of Gold, Torafu. Several of the cultivar names refer to plants with extremely abbreviated leaves (e.g., Compactus, Gyoko Ryu = Super Dwarf, Kyoto Dwarf, Nanus = Dwarf). Flowering May–Jun; flowers apparently produced uncommonly.

Naturalized distribution in the USA: **Alabama** (fide Kartesz 2010). Diggs et al. (1999) noted that *Ophiopogon japonicus* in north central Texas is widely cultivated and persists and spreads

vegetatively. A photo on the Bayou Preservation Association website <http://www.bayou preservation.org/> shows fruits of *O. japonicus* and the species is included among "The Invasive Exotic "Dirty Dozens" — presumably the photograph was taken of a naturalized plant somewhere in the bayou area around Houston in southeastern Texas but no documentation is provided. See Spaulding et al. (2010) for another photo of a fruiting plant of *O. japonicus* in a naturalized population. I have rarely seen fruits in cultivated plants.

Differences can be striking between longer-leaved horticultural forms and the dwarf, highly compact forms with leaves as short as 5 centimeters. The smaller plants and dwarfs are derived from the longer-leaved wild type.

Tamura (in press) recognizes three varieties within *Ophiopogon japonicus*. Var. *caespitosus* Okuyama (endemic to Japan) and var. *umbrosus* Maxim. (Japan, Korea, and China) both are characterized by stolons much reduced in length (compared to var. *japonicus*) and more vigorously branching rhizomes. Presumably the forms seen in USA horticulture all are var. *japonicus*, since all appear to produce creeping stolons and are strongly colonial.

6. **OPHIOPOGON PLANISCAPUS** Nakai, Cat. Sem. Hort. Tokyo 20. 1919; 33. 1920. *Mondo planiscapum* (Nakai) L.H.Bailey, Gentes Herb. 2: 25. 1929. **TYPE**: Japan.

Stolons usually creeping, slender, sometimes shorter. **Roots** with tuberous swellings. **Leaves** 15–30(–50) cm long (fide Tamura in press; apparently mostly less than 25 cm in popular cultivars), 4–6(–7) mm wide, 7–11-nerved, margins serrulate distally, apices obtuse. **Scapes** erect or arching, ca. 10–20 cm long, shorter than the leaves, flattened, winged, sometimes weakly 3-angled near the base. **Inflorescence** 10–32-flowered, rachis 4–8 cm long, often 1-sided; fascicles (5–)12–18; bracts lanceolate, proximal 8–18 mm long. **Flowers** pendulous, in fascicles of 1–3; pedicels 2–6 mm long; tepals pale purple to pinkish or white, 4.5–5.5 mm long; floral tube 2–4 mm long. **Fruits** ellipsoid-globose, 5–6 mm in diam., dark blue to blue-black or purple-gray at maturity. **Seeds** globose, 8–9 mm in diam., dark blue to purplish black or black at maturity. $2n = 36$.

Native and endemic to Japan. Native habitats are forest floors and forest margins; ca. 50–1000 meters elevation. **Common names**: **BLACK MONDO GRASS, BLACK MONDO, BLACK LILYTURF**. **Representative cultivars**: Arabicus, Black Dragon, Dark Beauty, Ebony Knight, Leucanthus, Little Tabby (v), Minimus, Nigrescens, Silver Ribbon (v), Silver Shine (v). Flowering (Jun–)Jul–Aug.

Not reported in the USA outside of cultivation.

Ophiopogon planiscapus is recognized by its large, white to lilac-tinged, campanulate flowers in fascicles of 1–3 and especially by its relatively narrow leaves that become (in the popular horticultural forms) dark purple to black (Howe 2004). Wild type leaves apparently are dark green (see photos in Online Appendix).

7. **OPHIOPOGON JABURAN** (Sieb.) Loddiges, Bot. Cab. 19, plate 1876. 1832. *Slateria jaburan* Sieb., Verh. Batav. Genootsch. Kunsten 12: 15. 1830. *Flueggea jaburan* (Sieb.) Kunth, Enum. Pl. 5: 303. 1850. *Mondo jaburan* (Sieb.) L.H. Bailey, Gentes Herb. 2: 27. 1929. **TYPE**: Japan. Nagasaki: Nomo-Saki, 1863, *C.J. Maximowicz s.n.* (holotype: presumably LE; probable isotype: P digital image!, with cited collection information).

A photo of a UPS Thunberg specimen in Bailey (1929, Fig. 3; Japan, "*Convallaria japonica* α") was noted by him as representative of *Ophiopogon jaburan*.

Convallaria japonica L. f. var. *major* Thunb., Fl. Jap., 139. 1784. *Flueggea japonica* (L. f.) Rich. var. *major* (Thunb.) Schult. & Schult. f. in Roemer & Schultes, Syst. Veg. 7: 309. 1829. **TYPE**: Japan. As synonym fide Tamura (in press).

Ophiopogon taquetii H. Lév., Repert. Spec. Nov. Regni Veg. 8: 171. 1910. *Mondo taquetii* (H. Lév.) Farwell, Amer. Midl. Naturalist 7: 43. 1921. **TYPE**: Korea. As synonym fide Tamura (in press).

Stolons absent or very short and vertically oriented. **Roots** with tuberous swellings. **Leaves** linear, 30–85(–130) cm long, (7–)10–18 mm wide, 9–13(–17)-nerved, upper margins minutely serrulate, apices acute. **Scapes** arching, 24–40(–75) cm long, shorter to longer than the leaves, strongly flattened, winged at margins. **Inflorescence** 45–120-flowered, rachis 6–10(–15) cm long, often 1-sided; fascicles 12–20; bracts narrowly lanceolate to lanceolate, proximal 15–85(–180) mm long. **Flowers** in fascicles of 3–8(–10); pedicels 4–6(–8) mm long; tepals usually white, rarely purplish, ovate-oblong, 5–7 mm long, slightly recurved; floral tube 3–6(–8) mm long. **Fruits** oblong, 10–15 mm long, violet-blue to dark violet at maturity. **Seeds** ellipsoid to oblong, (5–)8–14 mm long, white to deep blue at maturity. $2n = 36$.

Native to Japan, Korea, and Taiwan. Native habitats are primarily forests in coastal localities; ca. 5–50 meters elevation. **Common names**: **GIANT LILYTURF, WHITE LILYTURF, AZTEC GRASS, SNAKEBEARD, JAPANESE HYACINTH, JABURAN LILY**. **Representative cultivars**: Argenteo-variegatus (v), Aureo-variegatus (v), Caeruleus, Crow's White, Javanensis, Variegatus (v), Vittatus (v), White Dragon (v). Flowering Jun–Aug.

Probably not naturalized in the USA; see comments under *Liriope spicata*.

According to Fantz (2009, p. 390), "variegated selections [of *Ophiopogon jaburan*] are most commonly used in interior landscapes and conservatories. Outside [in North Carolina], the variegated selections usually did not survive into the second season."

8. OPHIOPOGON INTERMEDIUS D. Don, Prodr. Fl. Nepal. 48. 1825. *Flueggea japonica* var. *intermedia* (D. Don) Schultes, Syst. Veg. 7: 310. 1829. *Ophiopogon japonicus* var. *intermedius* (D. Don) Maxim., Mélanges Biol. Bull. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 7: 327. 1870. *Mondo japonicum* var. *intermedium* (D. Don) Farwell, Amer. Midl. Naturalist 7: 42. 1921. *Mondo intermedium* (D. Don) L.H. Bailey, Gentes Herb. 2: 25. 1929. **TYPE**: Nepal.

Flueggea wallichiana Kunth, Enum. Pl. 5: 303. 1850. *Ophiopogon wallichianus* (Kunth) J.D. Hook., Fl. Brit. India 6(18): 268. 1892. *Mondo japonicum* var. *wallichiamum* (Kunth) Farwell, Amer. Midl. Naturalist 7: 42. 1921. *Mondo wallichiamum* (Kunth) L.H. Bailey, Gentes Herb. 2: 21. 1929. **TYPE**: India (Silbet). Possible type: without collection data, *N. Wallich 5139* (PH digital image!). As synonym fide Chen and Tamura (2000b).

Flueggea jacquemontiana Kunth, Enum. Pl. 5: 304. 1850. **TYPE**: "India orientalis." As synonym fide Chen and Tamura (2000b).

Flueggea dubia Kunth, Enum. Pl. 5: 305. 1850. **TYPE**: "India orientalis." As synonym fide Chen and Tamura (2000b).

Flueggea griffithii Baker, J. Linn. Soc., Bot. 17: 502. 1879. *Ophiopogon griffithii* (Baker) J.D. Hook., Fl. Brit. India 6(18): 270. 1892. *Mondo japonicum* var. *griffithii* (Baker) Farwell, Amer. Midl. Naturalist 7: 42. 1921. **TYPE**: India ("Himalaya orientalis in sylvis ad Patkaye"). As synonym fide Chen and Tamura (2000b).

Stolons creeping, long or short. **Roots** with tuberous swellings. **Leaves** 15–55(–70) cm long, 3–15 mm wide, 5–9-nerved [13–23-nerved fide Fantz 2009], margins usually serrulate, apices

acute. **Scapes** projecting outward, (12–)20–50 cm long, shorter than or equalling the leaves, 3-angled to sometimes flattened and narrowly 2-winged. **Inflorescence ca.** (100–)200–300-flowered, rachis (2.5–)5–16 cm long [(8–)17–21 cm long fide Fantz]; fascicles (30–)45–55; bracts subulate, linear, or lanceolate, proximal 15–40 mm long. **Flowers** spreading, in fascicles of (1–)2–3(–6); pedicels 2–3 mm; tepals white to light purplish, oblong, ovate, or ovate-lanceolate, 4–7(–9) mm long; floral tube 2.5–3 mm long. **Fruits** oblong to ovoid to ellipsoid-globose, 8–11 mm long, 7–8 mm in diam, blackish purple to blue at maturity. **Seeds** ellipsoid, ca. 4 mm in diam., blue. $2n = 36, 54, 68, 72, 108, 112$.

As measured from plants cultivated at the University of Texas (see photos in Online Appendix). **Leaves** 23–40 cm long, 4–7 mm wide, 10–13-nerved, upper margins minutely serrulate, apices acute. **Scapes** arching-spreading, 8–14 cm long, shorter than the leaves, strongly flattened. **Inflorescence** 50–75 flowered, rachis 8–10 cm long; bracts ovate-lanceolate, proximal 4–5 mm long. **Flowers** in fascicles of 2–4(–6); pedicels 2.5–4 mm long; tepals white, oblong to oblong-lanceolate, 4–6 mm long; floral tube 1.5–2 mm long.

Native to the Himalayan region (India, Nepal, Bhutan, southwestern China) and Sri Lanka, to Bangladesh, Myanmar, Thailand, Vietnam, and Taiwan. Native habitats include evergreen broad-leaved forests, mixed forests, pine forests, bamboo forests, scrub, moist and shady places along streams, grassy slopes; 700–3000 meters elevation. **Common names**: **HIMALAYAN LILY TURF, WHITE MONDO GRASS, AZTEC GRASS. Representative cultivars**: Argenteomarginatus (v), Compactus, Stripey White. Flowering Jun–Oct.

Not reported in the USA outside of cultivation.

Ophiopogon intermedius has one of the most widespread native geographic ranges in the genus and shows high levels of genetic diversity (allozymes) as well as morphological and chromosomal variation (He et al. 2000). Within the genus, *O. intermedius* and *O. planiscapus* apparently are closely related (Tanaka 2001-III).

According to Fantz (2009, p. 390), *Ophiopogon intermedius* is "marketed commonly under *Liriope muscari* 'Variegated Evergreen Giant' or 'Grandiflora White.' Also, this species is confused with variegated selections of *O. jaburan*." The species is described by Chen and Tamura (2000b) as producing short, thick rhizomes; Fantz (2009) observed that it produces rhizomes (stolons) 7–28 cm long and forms dense tufted mounds with age. Fantz also noted that dwarf nursery selections of *O. intermedius* are 12–18 cm tall.

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Figure 1. Holotype of *Convallaria spicata* Thunb. at UPS. Identified here as *Liriope muscari* (Decne.) L.H. Bailey.

Figure 2. Detail from holotype of *Convallaria spicata* Thunb. at UPS. Structures at the base are fibrous roots, the thicker ones contractile.

Figure 3. *Liriope muscari*, typical expression. Note the short, thickened rhizome, apparently more commonly characteristic of this species in Japan than elsewhere.

Figure 4. *Liriope muscari*, typical expression. Base apparently strictly caespitose.

Figure 5 *Liriope muscari* sensu lato, "platyphylla" expression (see comments in text)

Figure 6. *Liriope muscari* sensu lato, "platyphylla" expression (see comments in text).

Figure 7. *Liriope muscari* sensu lato, variant of "platyphylla" expression (see comments in text).

Figure 8. *Liriope muscari* sensu lato, variant of "platyphylla" expression (see comments in text).

Averett, J.E. 2010. The status of *Chamaesaracha coniodes* and *C. coronopus* (Solanaceae). Phytoneuron 2010-57: 1–5.

THE STATUS OF *CHAMAESARACHA CONIODES* AND *C. CORONOPUS* (SOLANACEAE)

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ABSTRACT

An isotype of *Chamaesaracha coniodes* at the Gray Herbarium has been examined by several workers and bears a number of different annotations, some indicating that the species is synonymous with *C. coronopus*. All evidence indicates the types of *C. coniodes* and *C. coronopus* are referable to distinct species. The present contribution is meant to clarify the distinctions between the two. Averett (2005) described *C. darcyi*, which had earlier been included with *C. coniodes* by Averett (1973), and Henrickson (2009) subsequently described two additional species, *C. texensis* and *C. arida*, from western populations formerly treated within the boundaries of either *C. contodes* or *C. coronopus* by Averett (1973) and Rydberg (1896). *Chamaesaracha texensis* and *C. arida* are maintained here within *C. coniodes* and *C. coronopus*, respectively; discussions of all these taxa are provided.

KEY WORDS: *Chamaesaracha arida*, *Chamaesaracha coronopus*, *Chamaesaracha coniodes*, *Chamaesaracha darcyi*, *Chamaesaracha texensis*, Solanaceae

Examining specimens during the summer of 2008 at the Gray Herbarium, I noted that an isotype of *Chamaesaracha coniodes* (basionym: *Solanum coniodes*) had been annotated as *Chamaesaracha coniodes* by James Henrickson. On that label he also wrote "= *Chamaesaracha coronopus* as used by Averett." The annotation is not dated but, judging from its position to other annotations on the sheet, it was made prior to 1997.

There are actually three specimens on the GH sheet (Fig. 1), two isotypes (*Berlandier 1494* [=*234*]) and a syntype (*Berlandier 1463* [=*203*]) of *Chamaesaracha coniodes*. Turner, presumably following Henrickson's lead, annotated all three specimens as *C. coronopus* in 1997. I reannotated the two isotypes and the syntype at GH as *C. coniodes* in 2008. In my opinion, *C. coronopus* and *C. coniodes* are clearly separate and distinct species.

Henrickson has annotated specimens at MO as "*Chamaesaracha coronopus* var. *coniodes*" further indicating his belief that *C. coniodes* (Moric. ex Dunal) A. Gray and *C. coronopus* (Dunal) A. Gray are conspecific.

Subsequently, Henrickson (2009) formally recognized western populations of what was previously considered to be *Chamaesaracha coniodes* as a new species, *C. texensis*, but made a specific point of maintaining *C. coniodes* as a distinct species. He did not indicate what he considered to be the geography of the reduced *C. coniodes*.

In that same paper Henrickson proposed a second new species, *Chamaesaracha arida*, for western populations that Averett (1973) and all previous workers had included within *C. coronopus*. While Henrickson made no specific statement to the effect, it appears that he no longer considers *C. coniodes* to be a synonym of *C. coronopus*.

Concerned that Henrickson's newly described species and various herbarium annotations might cause confusion, and in anticipation of a more comprehensive revision of *Chamaesaracha* (in prep.), I provide here a brief account of *C. coniodes*, *C. coronopus*, and the two newly described species.

CHAMAESARACHA CORONOPUS (Dunal) A. Gray, Bot. Calif. 1: 54. 1876. *Solanum coronopus* Dunal in DC., Prodr. 13: 54. 1852. *Withania coronopus* (Dunal) Torr., Bot. Mex. Bound. Surv. 155. 1859. *Saracha coronopus* (Dunal) A. Gray, Proc. Amer. Acad. Arts 10: 62. 1874. **TYPE: USA. Texas**. Bexar Co.: "inter Laredo et Bejar [San Antonio]," Mar (?) 1828, *Berlandier* exsicc. *1513* (holotype: G-DC!, isotype: K!).

Chamaesaracha arida Henrickson, Phytologia 91: 186. 2009. **TYPE: USA. New Mexico**. Santa Fe Co.: ca. 19 mi S of Santa Fe on Hwy 85, 15 Jun 1968, *J.E. Averett & A.S. Tomb 339* (holotype: TEX!; isotypes: MO!, GH!).

Averett (1973) noted the type locality of *Chamaesaracha coronopus* to be in the vicinity of Laredo, Texas, incorrectly citing Berlandier's collection number *1494*. I subsequently corrected this (Averett 1974) and included an informal insert in my distributed reprints. Only a single collection was cited by Dunal in his protologue, this being *Berlandier* exsicc. no. *1513*. The isotype at Kew notes the locality as "Rio Medina," which on Berlandier's route would be in present-day southern Bexar Co., Texas.

Chamaesaracha coronopus is the type species of the genus; leaves characteristically are essentially glabrous or with sparse branched hairs and vary from 4–11 times as long as broad, averaging ca. 6. Leaves from the type itself are ca. 4.5 times as long as wide. In Dunal's original description, the species is said to have glabrous or glabrate stems and subglabrous peduncles, which is consistent with the type and with the populations in south Texas and northern Mexico.

Henrickson distinguished *Chamaesaracha arida* from *C. coronopus* (Dunal) A. Gray [mistakenly citing the authors as (Moric. ex Dunal) A. Gray] by leaves with short, scattered, broad-based, forked to branched hairs, and having linear to linear-lanceolate leaves with undulate, toothed, or pinnately lobed leaves. Only a brief Latin description was provided, without any comment about the geographic distribution of the proposed species or how it compares to *C. coronopus*. Henrickson noted that he studied type material of *C. coniodes* but not that he saw type material of *C. coronopus*.

Most, but not all, of the western populations of *Chamaesaracha coronopus*, as treated by Averett (1973), do have the short, branched hairs that Henrickson described, but other consistent differences from these and populations of *C. coronopus* in south Texas are not found. Moreover, equal or greater differences are seen among several populations in the western United States and northern Mexico. I see little justification for the recognition of *C. arida* as a separate species but, with further analyses, it plausibly might be recognized at the varietal level.

CHAMAESARACHA CONIODES (Moric. ex Dunal) Britt., Mem. Torrey Bot. Club 5: 287. 1895. *Solanum coniodes* Moric. ex Dunal in DC., Prodr. 13: 64. 1852. **LECTOTYPE** (Averett 1973): **USA. Texas**. Frio Co.: "Cañada Verde inter Laredo et Bejar [San Antonio]," Feb-Mar 1828, *Berlandier* exsicc. *1494* (= *234*) (G-DC; isolectotypes: GH!, K!).

Chamaesaracha texensis Henrickson, Phytologia 91: 187. 2009. **TYPE: USA. Texas**. Kinney Co.: open rocky soil near the Nueces River, Hwy 334, 17 Apr 1957, *D.S. Correll 15965* with *Rollins & Chambers* (holotype: LL, photo!).

Dunal, in his protologue, cited two exsiccatae numbers by Berlandier, *1463* and *1494*. The

specimens probably were collected near San Miguel Creek in what is now southeastern Frio County, the latter number, *1494*, in March of 1828. Both collections are on the type sheet at GH.

Chamaesaracha coniodes, as treated by Averett (1973) and Rydberg (1896) is a wide spread species ranging from south Texas and adjacent Mexico into west Texas and north to Oklahoma, Colorado, and Kansas. The species is one of the more variable of the genus, exhibiting essentially all forms of vestiture found in the genus as well as a variety of leaf shapes. Plants vary in stature from robust to relatively small.

Unfortunately, type material of *Chamaesaracha coniodes* possesses a fairly dense covering of dendritic hairs which is atypical of the species. Populations of *C. coniodes* typically have simple, unbranched trichomes with an understory of glandular hairs. Averett, and apparently also Rydberg, was aware that the type collection of *C. coniodes* had branched hairs. Rydberg specifically noted the occurrence of branched hairs but further noted that, "The most common form is very hirsute, often glandular viscid, but not at all stellate."

In other characters, most populations are comparable to type material and to a few other populations in south Texas. While dendritic hairs are atypical in this species, they are not unknown and appear in seemingly random populations in this and other species. Indeed, in most of the species one or more populations with an atypical vestiture can be found.

Regarding *Chamaesaracha texensis*, Henrickson (2009) stated that after examining type material of *Chamaesaracha coniodes*, he concluded the type was a different taxon from the western populations of what Averett and Rydberg had included in *C. coniodes*. He described the latter as *C. texensis*. However, rather than distinguishing the species from *C. coniodes*, he contrasted the taxon in his diagnosis with *C. sordida*, another distinct taxon, which he noted, is diploid ($n = 12$) while most of the populations he includes in *C. texensis* are tetraploid (as was noted by Averett 1973). The recognition of *C. texensis* would leave *C. coniodes* consisting of only a few populations in what looks to be simple populational variation. I see little reason to recognize *C. texensis* as distinct from *C. coniodes*.

CHAMAESARACHA DARCYI Averett, Monogr. Syst. Bot. Missouri Bot. Gard. 104: 350. 2005. **TYPE**: **USA**. **Texas**. Palo Pinto Co.: near Lake Possum Kingdom along Hwy 36, 27 Jun 1969, *J.E. Averett & M. Bierner 474* (holotype: TEX!; isotypes: GH!, MO!).

Averett recognized this species to account for an eastern group of populations largely restricted to the Rolling Plains of north-central Texas but extending eastward to the Cross Timber regions of Texas and adjacent Oklahoma. The species is very close to *Chamaesaracha coniodes*, having a dense vestiture of branched, dendritic hairs like those found on the type of *C. coniodes*. However, *C. darcyi* typically has more deeply lobed or toothed leaf margins and a nearly prostrate habit. The species also is disjunct from populations in south Texas with a similar vestiture and east of populations with unbranched simple trichomes. Unfortunately, the chromosome number of *C. darcyi* (tetraploid, $n = 24$) is known from only one population, the type.

Discussion.

Vestiture is an important character in the taxonomy of several of the genera surrounding *Chamaesaracha* such as *Solanum* (Seith & Anderson 1982) and *Physalis* (Seithe & Sullivan 1990). Within *Chamaesaracha*, pubescence may be under relatively simple genetic control. This likelihood is amply attested to by the work of Oppenheimer et al. (1998), who found that a single gene could account for the production of dendritic hairs in the genus *Arabidopsis*. Similar genetic variation may account for some of the variability observed among the species of *Chamaesaracha*. Nevertheless,

leaf and stem vestiture is fairly, but almost never completely, consistent within a taxon and remains an important and useful character in separating the several taxa of the genus. However, pubescence must be used in conjunction with other characters, especially leaf shape. Except for *C. rzedowskiana* Hunziker, no species of *Chamaesaracha* exhibits a unique character but, rather, each possesses a syndrome of characters.

In summary, *Chamaesaracha coniodes,* including *C. texensis*, is densely pubescent, whether with dendritic or unbranched trichomes. The leaves average ca. 2.5 times as long as wide and lack the deep lobed margins found in *C. coronopus,* including *C. arida.* The leaves of the latter are elongate-linear and average about 6 times as long as wide. In addition, they are sparsely pubescent to glabrate, including the type. In short, the types of *C. coronopus* and *C. coniodes* differ in leaf shape and vestiture and clearly represent distinct species, a fact recognized by every previous worker.

Whether the western populations of either *Chamaesaracha coronopus* or *C. coniodes* are separated from the south Texas populations, is a matter for further study. However, as noted in the introduction, pubescence may be under relatively simple genetic control and variability of such traits is observed among and between populations of most of the species. A different vestiture, without other characters, would provide little support for the recognition of either *C. arida* or C. *texensis*.

The recognition of *Chamaesaracha darcyi* as a separate species also may be questionable. The populations concerned are disjunct from similar populations in south Texas having dendritic hairs and largely isolated from all other species. They are, however, quite similar in leaf shape and vestiture to the type of *C. coniodes*. In short, additional study may suggest varietal status for *C. darcyi*.

In Henrickson's 2009 paper, he considered *Chamaesaracha villosa* and *C. crenata* to be conspecific and proposed the use of *C. villosa* for the combined taxon. The status of *C. villosa* and *C. crenata* is more fully discussed in a separate paper (Averett 2010).

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Figure 1. Isotype of *Chamaesaracha coniodes* at the Gray Herbarium.